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N°. XXXII.

TURNER'S

SACRED HISTORY

OF

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THE

SACRED HISTORY

OF

THE WORLD,

AS DISPLAYED IN

THE CREATION AND SUBSEQUENT EVENTS TO THE DELUGE.

ATTEMPTED TO BE

PHILOSOPHICALLY CONSIDERED, IN A SERIES OF LETTERS TO A SON.

BY SHARON TURNER, F.S.A. & R.A.S.L.,
Author of "The History of England," "The History of the Anglo-Saxons," &c. &c.

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PREFACE.

FORTY years ago the author felt the want of a book like that which is now offered to the public in the following pages. At that period of his life he wished a selected and concentrated view of such facts and reasonings on the creation, intellectual design, and divine economy of the world we inhabit, as would correspond with the other knowledge he was acquiring; and which at the same time should be so conceived and shaped as to suit the modern topics and style of thought and reasoning, in which the philosophical subjects that interested him were beginning to be presented. Finding none at that time so collected and represented as to satisfy his young curiosity, or sufficiently adapted to meet the ideas and difficulties that were arising around him, he was obliged to make such outlines of this great subject, for his own information, as occasional studies and opportunities enabled him to form. Amid these sketches for his private use, a latent desire insensibly occurred to attempt at some part of his life to supply, for the service of others who should participate in these sentiments, what he found to be necessary for his own satisfaction. Gradually this wish increased into a more determining purpose, and has, as other motives concurred, produced the resolution in his mature age of endeavouring, for the benefit of younger minds who may reason and feel as he did, to arrange

far more certainly obtain. Nothing tends more to consign a writer to oblivion, or to that future depreciation which is worse than to be forgotten, than to depart from the grand truth of Nature, and to set up idols and fallacies instead. No one patronises another's fantasies, however fondly he may cherish his own; and thus, if that fame which is attended by the esteem and blessings of posterity be our coveted delight, it will never be attained in philosophy if we desert its eternal and fundamental verities. A steady adherence to these will most surely procure both personal immortality and national superiority.

If the British empire keep its reasoning mind firmly attached to the great Newtonian principle of the Divine causation of all things, its men of science will always be in the foremost ranks of intellect, honour, and celebrity.

To have any solicitude about criticism on the present publication would be absurd and unbecoming on such a subject. Not a line has been written with any reference to human reputation; and if that had presented itself as the actuating motive to its composition, not a line ought to have been written on the themes of this work for the purpose of obtaining it. But it is the duty of every author, in all his publications, to execute every part with his best care and ability. He expects this attention from others, and should never be deficient in it in his own publications. This duty has not been neglected in the ensuing pages. In these it has been a constant endeavour to collect authenticated facts—to state them fairly—to reason correctly about them—to express the natural feelings which have arisen as they were contemplated—and to make the general composition perspicuous, readable, and, if possible, not uninteresting. The first wish was to be serviceable to those in whose welfare the author is more immediately concerned. The larger hope has been added to this, that what should eventually be useful to them might

not be unacceptable to others. We have all arisen to sentient being in the mighty system of which we are a part. Progression and happiness are desired and pursued, and are attainable by all. The varying ocean of human life is the present scene, in which these are to be acquired, so long as we remain in it. Here also we are to fit and prepare ourselves for securing the continuation of these blessings in the unknown regions of ethereal space into which we are all passing. The Lord of this world is the Sovereign of every other; and this consideration makes it important to us to gain the fullest knowledge of his mind, ideas, and feelings, that we can obtain from his creations around us, and from all the sources through which he has communicated them to us. If the following work shall, in its present essay or future progress, assist any to form right conceptions and exhilarating hopes of this stupendous Being—so awful, yet so good—so invisible, and yet so manifest,—and of his moral arrangements and conduct of human affairs, and of his ulterior destination of his improveable creatures—the main object of its author will be fully and pleasingly accomplished.

Winchmore-Hill, Middlesex,
16th February, 1832.

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THE

SACRED HISTORY

OF

THE WORLD.

LETTER I.

On the Creation of the Earth—Light—The Atmosphere, and the Separation of Land and Sea.

My dear Boy,

In this aspiring age no mind seems disposed to rest contented with either ancient opinions or ancient institutions; at least not without subjecting both to examinations and criticisms which oftener unsettle and disturb than benefit and satisfy. But every period has its own character of action and thought; and the present is distinguished by a more than ordinary sensibility of existing errors and imperfections, and by a diffusing desire to avoid or correct them. This tendency has spread, or is spreading, into every topic which has interested or agitated human nature. All subjects have been exposed to much skepticism, and to rigid inquiry. The mind has become unusually restless in exploring the causes and reasons of all things; and expects and exacts, that when it is required to believe, it should have full elucidations of the grounds and principles on which its assent is required, in addition to the knowledge or evidence of the facts or things themselves. Every department of the natural sciences has been subjected to this scrutiny, and has been benefited by such rigid investigations. The known is expected to be accounted for; and if it cannot be rationally explained, it is depreciated and discredited, even where it cannot be disproved, and ought not to be denied.

When the spirit of fair inquiry acts to this excess, we cannot but lament its unreasonable perversion.

If such has been our experience as to the laws and phenomena of physical nature, we cannot be surprised that the same exploring or criticising spirit has been unhesitatingly directed to whatever is invisible, supernatural, or beyond the daily course and material order of things. The individual mind of every one can only act according to what it is, or has made itself, or been led to be; and if it has become habitually dissatisfied or discursive, it will be so in all things. As soon as disquisition takes the place of acquiescence, and we prefer to inquire rather than to venerate, the thoughts will not be restrained from doubt or discussion, even where we ought to pause, to submit, and to believe. No want of adequate knowledge, no state of ignorance will produce these deferent qualities, so useful, so necessary to us all; but on the contrary, appear universally to increase the appetite for objection and mistrust. It is often because we do not sufficiently know our subject of discussion, that we most keenly dispute about it. Numerous difficulties always arise to an active mind on every point on which its information is slender. It is ignorant of its ignorance until it gets larger knowledge. The superficial are commonly the most pugnacious; and we must be superficial before we can be well informed. Thus in the best intentioned minds doubt and objection, controversy and disbelief, cannot but precede knowledge, judgment, right opinions, and a satisfied conviction, in an age which makes intellectual subjects the topics of its conversation, its studies, or its business.

Among the great themes of human thought, this inquiring spirit has for some time applied itself to the grandest of all—RELIGION; and with no very favourable result, in a large portion of mankind. So much superstition and worldly policy had been mingled with this most deeply interesting of all mental inquiries, that earnest desires have arisen to expunge it altogether from the human mind; and therefore it has been attacked from all quarters, and by every means of intellectual assault. Many also, by the fair use of enlarging judgment, have felt difficulties, which, without producing in them the hostile feelings of decided enemies, have led them to suspend their assent, and to seek for the elucidations that would remove their hesitation. In-

genuous youths, who are fond of study, usually fall into this *state* of mind. I have experienced it in myself; I see it in those around me, and in all countries; and I have no doubt, with your habit of mental application, that it will more or less arise in you. Religion will be a prominent portion of your education and pursuits: what all feel, who examine it with growing thought and knowledge, will occur to you; and the perception of this, as to yourself, and as to many whom I highly esteem, and as to others whom I should wish, as far as I am able, to assist and benefit, has induced me to attempt the present composition.

My purpose in these letters will be to review the sacred history of the world from the creation to the deluge, as it has been narrated to us in the most ancient history and book now existing; and which has been universally venerated in the Christian world for its truth and origin, from the commencement of the Christian faith.

From this authority we must take the facts that will form the foundation of the work. But the peculiar object of these letters will be to consider these facts, with a due recollection of the reasoned science, and of the varied knowledge, and enlightened investigation of the times we live in, so far as the defective information of the writer may reach; and to take those views of extended thought which may harmonize the recorded circumstances with the philosophical judgment. Fact and sound reasoning should always agree and illustrate each other. If our facts and our reasonings do not concur, one of these must be erroneous. And, as in all revealed truths, what is revealed must be true, if that is found to be at variance with our intellectual deductions, the mistake must be in our reasoning or in our inferences. While this discrepancy lasts we may be sure that we have not hit upon the right solution. However ingenious or plausible our argumentations may be, we have missed the just theory; we have not found the real key; we have not penetrated to the law and principle from which the revealed facts have proceeded, and from which alone the full comprehension of them can be derived.

In the following reflections, the important subjects of thought which occur to the inquiring mind on the recorded subject of the primeval history of man during the first period of his being—a period which in the shortest computa-

tion comprised the first 1656 years of human existence—will be considered as they arise,—with continual deference to the authority from which the facts are taken, but with the exercise of that mental investigation which is usually termed philosophical. No arrogant assumption is intended by this epithet: it is a word which is used to denote an inquiry into the principles of what we discuss, according to those of our just knowledge on all natural phenomena—a mental investigation, that searches for intelligible causes and agencies consistent with those with which we are already acquainted, and which seem to be most certain. It is an endeavour to illustrate by reason, what we believe upon proper authority. I have always found my own belief most steady whenever I traced it to be in coincidence with my other knowledge; and it is my earnest desire that in all things your belief may be accompanied by your judgment; and that faith and reason may in you be always in that pleasing union, which will ever constitute the soundest and largest mind, and yield the greatest comfort. I cannot pretend to do more than to explain to you those inferences and reasonings which have satisfied myself. It is absurd for any human being, uninspired, to domineer over another. I would not attempt to do so. It would be both unjust and foolish. It would fail in its effect, and be contrary to the well-founded claim which every one has to judge for himself, under his own responsibility to the Deity, who rightfully claims our implicit obedience and immediate acquiescence in all that he discloses. But, between man and man, no one can with any justice or reason tyrannise or dogmatize over others.

That we belong to a class of beings whose existence will not cease with their present earthly life, but will continue elsewhere—although the body we now animate will decay, and separate into its elementary particles—you and I believe, from reason, from our intellectual feelings, from the consent of the best philosophers of all ages, from the traditions of all nations, and from the deciding communications of the Christian revelation. We do not perish when our material frame dissolves. Our thinking and feeling principle survives its fleshly limbs and organs, which are but the instruments of its use and pleasures here; and will, after the visible death of our corporeal frame, and in re-

union with another, possess its consciousness, its sensitivity, and its active powers in some other place, and under such other circumstances as its Creator shall appoint. We are on this earth solely from his special designation. Neither we nor our ancestors have ourselves constructed it for our habitation. It has been provided for our present existence before the birth of our race began. It continues for the reception and residence of others when we disappear. We are placed on it, without any previous consultation with our will or choice. We find every thing in it most artificially and specifically made, and all independently of us. Such as it is, we have no option, but to be in it as it is. The whole of it has been framed, in every part, by some other and superior power, who has formed it upon his own plan, and for his own purposes. Our term of existence in it is that which he has been pleased to fix, and to which he has limited our enjoyment of it. This special fabrication of all things which now surround us, leads the mind to infer and believe, that our next state and mode of existence will be as elaborately and specifically provided, according to his appointing will and established designs. In all periods of our being, our Creator must be our disposing governor, so far as he shall choose to be so; and it therefore becomes an object at all times of the deepest interest to us to ascertain, if it be possible, what his intentions and wishes are with respect to our present and future destinies. What he has imparted to us of his *will and expectations*; what commands he has *imposed*; what information he has condescended to convey; and what intercourse he has been pleased to hold with any portion of our progenitors, in the anterior ages of our history:—the more we know of these important subjects, and the more just our notions of them shall be, the more clearly we shall discern how we ought to direct and regulate both our conduct and our reasoning speculations, for the improvement of our intellectual nature, and for the preservation and increase of our personal happiness. These topics are comprised in the SACRED HISTORY of the world. We can know nothing of the thoughts and purposes of the Divine mind, but from its own revelations of these to us. We possess a record of these, in the Jewish and Christian Scriptures, and we have no other authoritative memorial of them. Without these, we should be

in utter darkness on this most interesting subject. On these, therefore, all our knowledge of divine things must be formed: on their direct information, so far as that extends; and on those further probabilities, which may be deduced from them by correct inferences, cautiously and reverentially made, in addition to what they have positively declared. The grand and beautiful creation furnishes an illustrating comment on these revealed truths; and a careful consideration of these sources of our most important knowledge will enable us to take such views of the moral constitution and course of things, which have been framed for our terrestrial globe, as may make them, in some degree, more intelligible to us. Our present inquiries will be confined to the first eras of the world which were closed by the deluge, because most of the essential principles of this great subject will arise to our contemplation from the events of this period. If we can but think justly on these, they will enable us to reason more correctly on the subsequent history of mankind; and they will give to this subject, so repulsive in some of its results and features to our ordinary feelings, a more connected, orderly, and rational aspect, than it has generally been thought to present to the deliberating understanding.

It was about 6000 years ago, according to the chronology of the Hebrew Scriptures and their numerals, which, after much thought, I cannot but deem the true standard of the duration of the *human* existence, that it pleased the Almighty Sovereign of the universe to determine on the creation of the earth which we inhabit, and upon the formation of those races of animated beings which appear upon it. His purposes in this grand operation of his power, and the degree and course of agency and interposition which he chose to pursue with regard to those whom he called into being upon it, we can learn only from his special communications, and from the authentic narratives of his intercourse with us. On these, therefore, our eye must be fixed, as from these alone can the sacred history of our world be composed. They will be the foundation of our present investigations.

Our globe consists of its earthly structure—of the ethereal fluids which move upon it and above it—of the watery masses and effusions—of the vegetable kingdom—and of

the animated races. It is subjected to the potent and varied agencies of the sun and moon. It rolls, with undisputed and unsupported freedom, through a boundless space; and it is connected by immediate relations with the planets of our system; more remotely with the splendid stars, whose nature and numbers we have not yet ascertained; and occasionally, at intervals, some of which are recurrent, with the rapidly-moving comets. These rush suddenly and unexpectedly, for the most part, into our visible heavens, by laws and for purposes yet unknown; rather advertising us of their existence, and amazing us by their appearance, than exercising any perceptible effect, or imparting any knowledge of their composition, of the causes of their journey, or of the places from which they come and to which they so mysteriously depart. In this grand system of existence, man is the most intelligent being that is visible to our material sense; and we have as yet no decisive evidence that any thing, below the Creator, will be ultimately his superior.

The sacred history of the world is built on the grand truth expressed in the first verse of the Pentateuch:

> "In the beginning GOD (*Elohim*) created the heavens and the earth."*

This is the foundation of all religion, whether popular or philosophical. The intellectual world possesses an invaluable treasure in this simple, but emphatic information. It deserves the epithet invaluable, because it is a fact which could be certainly known to us only from revelation, as no human eye could have witnessed the event; and because the greatest minds of antiquity were in doubt and darkness, and in opposition to each other on this subject, as we should still be, if the book of Genesis had not descended to us. Instead of deriving the world from GOD, it was more common among the classical nations to derive their gods from the world. Hesiod, as well as Epicurus, makes his divinities to be an order of beings springing out of the material universe. Several pagan nations, even in our own times, thus account for their existence. Few have thought the Deity to be the Creator of the earth or of the heavens; and the mind had become so confused on this point, that it was

* Genesis, ch. i. ver. 1.

more generally supposed, that either these were eternally what they are, or that they were united into what we see them to be by a fortuitous concourse of self-moving atoms. Such ideas were highly patronised in ancient times; and until the prevalence of Christianity diffused the knowledge and authenticity of the Mosaic record as to the origin of things, nothing was positively known or rationally believed about it. The more we investigate the conflicting and chimerical opinions of mankind on this great topic, the more we shall appreciate the first chapter of Genesis. On no subject of its thought has the human mind been more fantastic than in its suppositions on the origin of the gods whom it chose to worship, and of the material world in which it was residing. Revelation has banished these, by giving to us the desirable certainty.

The theory, that the component atoms or particles of things could have moved themselves into the beautiful forms and scientific arrangements and motions of visible nature, was felt to be incredible by some of the finest minds of antiquity, and finds no patronage now from the true philosopher. Design, contriving thought, the adaptation of things to each other, and the skilful production of important ends by the application and co-operation of the fittest means, are so manifest in the structure of the earth, in the formations of the animal and vegetable kingdoms, and in all the astronomical phenomena, that no judicious inquirer will attempt to support the Lucretian reveries. The more favoured opinion of some, who desire to remove the Creator from the material universe, is the arbitrary assumption, that the system and course of things which we admire has had no origin at all, but has been eternally what we see it to be. This is no new conception of the human mind, but it is that to which those who are adverse to religion, and who discredit Revelation, seem to be now most inclined to adopt. For this reason, it may be useful to suggest an observation, which seems to prove it to be an impossible hypothesis.

If the material world had been one uniform homogeneous mass, its eternal existence would have been always a possibility. It would then not have contained any evidence in itself to contradict the supposition. But the actual fact is, that all visible nature is a multifarious association of very compounded substances. Nothing is simple—nothing

is uncompounded. Every thing we see, feel, or handle is a composition, a mixture or union of more particles or of more elements than one. Not merely the grosser earthly bodies are so, but even the water, the air, and the light are in this compounded state. Now, it is impossible that any compound can have been eternally a compound. Composition and eternity are as incompatible as to be and not to be. The particles of which compounds consist must have been in some other state before they were compounded together. The single condition of the elements must have preceded their union in the composition; and thus it is physically impossible that a compound can have been eternal. The schoolboy perceives at once that his plum-cake cannot have been eternal. The plums, the flour, the butter, the eggs, and the sugar, of which it is composed, must have been in some other places and state, before they were brought together to make the substance which gratifies him. So the mighty world we live on, the rocks, the mountains, the minerals—so every substance around us, animate and inanimate,—cannot have been eternal, because every one is a combination of numerous particles, usually very heterogeneous, and the primary elements of each must have been in their elementary state, and in some other position, before they moved and joined into their compound one.

The process of creation, in the primitive construction of our earthly fabric, has not been detailed by the Hebrew legislator. He mentions no more of its massive composition than this short sentence:—

> "The earth was without form and void; and darkness was upon the face of the deep. And the Spirit of Elohim moved upon the face of the waters."*

---

* Gen. ch. i. ver. 2. The fact recorded by Moses, that darkness accompanied the primeval state of things, appears to have been preserved in the traditions of most nations. It is an opinion as universal as it is ancient.

The Otaheiteans and the contiguous islanders "refer the first existence of their principal deities to the state of darkness, which they make the origin of all things. These are said to be 'fanau Po,' born of night. Po, the world of darkness."—Ellis, Polyn. Researches, vol. 2. p. 191. The Anglo-Saxons began their computation of time from night, and their year from that day in winter corresponding with our Christmas, which they called "Mother night," as if the parent of all things. The Ancient Egyptians thought night older than day.—Plut. Sym.

"The earth was without form." It had therefore to be put into form. Its material substance had been created, but had not been arranged into any specific formation. It was also "void;" it was therefore empty; vacant of all that now adorns its surface, or that was afterward made within it. It had to receive and to be replenished, both internally and externally, with all those additional and organized things and beings, or more specific metals and minerals, which were intended to be within it and upon it. As "darkness was upon the face of the deep," there was in its primeval state a deeper abyss—a vast obscure concavity; and as "the Spirit of God moved upon the face of the waters," its surface must have been covered with the aqueous fluid. Thus the first state of our earth which is noticed to us after the general creation is that of a dark mass, unformed and void, with an abyss within, and whose surface was covered with moving waters, but on which the Divine Spirit was operating. The effects of this operation are not stated, but we may presume them to have been to produce those formative arrangements which constitute its present structure,—its great masses of rocks and strata—its geological system and construction.*

l. 4, p. 95. They made "unknown darkness" the first principle of nature. Damascius περι ἀρχῆς MS. quoted by Bryant, p. 153. The ORPHEAN fragments say, "I will sing of Night, the genitor of gods and men. Night, the genesis of all things."—Orph. Gesn. p. 317.

ARISTOTLE thus recognises the opinion: "The Theologi say, that all things are born from night. The Physici, that all things were mingled together."—Metaph. l. 14, c. 6. Sanchoniathon mentions the same from the PHENICIAN accounts: "He places, as the beginning of all things, a dark air and a turbid chaos."—Euseb. Rep. l. 1, c. 10. HESIOD makes a chaos the origin of all things, from which Erebus and Night arose.—Theog. And ARISTOPHANES, in his drama of the Birds, expresses the same notion, as if it was the common idea of the intelligent men of Greece.

"First of all was chaos and night; dark Erebus and gloomy Tartarus. There was no earth, nor air, nor heaven, till obscure Night, by the power of the wind on the wide Erebus, brought forth an egg." Quoted by Lucian in Philop. and by Suidas.

OVID shows that the belief had been retained by the Romans, for he derives all nature from a chaos, in which there was neither light nor form. Metamorph. l. 1.

* The chaos is thus mentioned in the ancient Scandinavian VOLUSPA.

In the era of the Ages—
There was no land nor sea;
Nor winds on a vast ocean.

At this point of time, when its specific composition was taking place, the Divine command was issued for the appearance of the luminous fluid. The introduction of this grand agent of the creative process is mentioned with that sublimity of diction which arises from the emphatic conciseness of imperative dignity:

"And Elohim said, 'LIGHT BE!' and light was."*

It came instantaneously, pouring on and pervading the terrestrial mass; and the operations of this beautiful element,

---

Earth yet was not: nor the heaven above,
Only the abyss of chaos, and no grass.
Hist. Angl. Sax. vol. i. p. 242.

Diodorus Siculus thus represents the notions of the old Egyptians, to the same purport: "In the establishment of all things from the beginning, heaven and earth had one form, their nature being mingled together: but afterward, the bodies separating from each other, the world received all that arrangement which is now seen in it. The air acquired a continual movement, and the fiery particles ascended to the most meteoric or highest regions."—L. 1. p. 7. But the notions of the CHIPPEWYAN Indians in North America approach the Hebrew statement with a curious poetry of conception. Mackenzie thus heard them related, when among them: "They believe that at first the globe was one vast and *entire ocean*, inhabited by no creature, except a mighty bird, whose eyes were fire and whose glances were lightning, and the clapping of whose wings was thunder. On his descent to the ocean, and on his approaching it, the earth instantly rose up and remained on the surface of the water."—Mack. Travels, cxvi. Strabo mentions, from Megasthenes, that the Brahmans of India at that time taught that the world was spherical, and had arisen from water, and the Divinity had made it, and pervaded the whole of it.—Lib. 15. p. 1040. So Thales declared water to have been the beginning of things, and that God was the mind that had out of that formed every thing.—Cic. de. Nat. Deor. l. 1.

The Sanscrit Institutes of MENU have in this point a remarkable coincidence with Moses:—

"He—the Soul of all beings—having willed to produce various beings from his own divine substance, first, with a thought created the waters, and placed in them a productive seed.

"The waters are called *nara;* because they were the production of Nara, or the Spirit of God: and, since they were his first ayana, or place of motion, he is thence named Narayana, or *moving* on the waters." Sir Wm. Jones. Instit. of Menu, p. 2.

* Gen. ch. i. ver. 3. The Hebrew words of command are only four, which express, even more concisely than the Greek translation of them, that sublimity of effect which Longinus so much admired. They are as in the text יְהִי אוֹר וַיְהִי אוֹר. The Latin gives also their dignified brevity, "Sit lux! et lux fuit." The third person of the imperative in our language, "Let there be light and there was light," lessens the force, by multiplying the words of the passage.

whose penetrating, universal, and marvellous agencies are yet so little understood, fulfilled its Author's wishes:

"Elohim saw the light, that it was good."*

From light we cannot separate the recollection and companionship of heat. They are now found to be so generally coexisting, in the latent or the active state, wherever either is present, that they are thought to be modifications or different conditions of the same element. When both these occur, we have fire. Fire is luminous heat, or heat in the state of light. The sun's light has the effect of both heat and light. All flame from all combustible bodies, our domestic and furnace fires—volcanic light, the electrical lightning—all these exhibit both light and heat. The Hebrew word used by Moses, *aor*, expresses both light and fire. We may therefore reasonably infer, that light came to the earth in the state in which we now almost universally find it, as both light and heat; and that from the moment of its presence, the phenomena and agency of light, heat, and fire began, wherever it spread—and within the earth as well as upon it.† The interior of the earth, as far as it is yet known, exhibits everywhere the agency of light and heat, either in their combined operation of fire, or in their separate states, or other modifications. Submarine volcanoes are still occasionally bursting up, as indications of the fiery agencies that are yet acting beneath our surface.‡ Thus the Mosaic record expresses the true principles of our

*Gen. ch. i. ver. 4. With this account of Moses, that of Orpheus, as his verses are cited by Timotheus the chronographer, in Eusebius, singularly coincides. When the Θεος, the Deity, was making the world, "an ether spread around, within which was chaos, and dark night covering all things under the ether. The earth from the darkness was not to be seen, but he said, that light breaking through the ether (ῥῆξεν τὸν αἰθέρα) enlightened all the creation."—Gr. Chron. p. 4.

† Dr. Thomson thinks "we are certain that no particle of light weighs the one-millionth millionth part of a grain."—Chymistry, vol. i. p. 390. And yet it is continually reflected and refracted by solid bodies. The incredibilia of science are numerous, and ought not to be forgotten when we are judging of other things which are not more incredible.

‡ The public papers mention the submarine explosion of an island, in July, 1831, in that part of the Mediterranean, lat. 37° 6′ and 10° 26 long. from Paris, which flows near Trafane, on the S. W. coast of Sicily; having an active volcano with a crater in its centre from which lava was flowing.

geological formations. These have proceeded from the action of the watery or of the fiery element, or are the alternate effects of each. We learn from the book of Genesis that both these were active agents in the creation, from its very commencement. Water preceded, and began its operations as the Spirit of the Creator directed them. Light descended immediately afterward, when ordered, and, with its modifications or attendants, heat and fire, exerted their powerful agencies. Thus the great scientific truth so recently ascertained, after many contending systems had been upheld and thrown down, that both the watery and fiery elements were actively concerned in the geological construction of our earth, is implied or indicated by the Mosaic narration, instead of being inconsistent with it.*

The next act of the Deity was to make a boundary, or division, between the effect of the visible presence or action of light and that darkness which arises from its latent state or disappearance, calling the duration of our luminous sense of it "day;" and the time of its absence "night."† Their succession was made to constitute that portion of time which we designate by a natural day. "The evening and the morning were the first day."‡ Our earthly day is that

* Dr. Bradley, above a century ago, inferred, from his observations of the heavens, that light comes to us from the sun in about eight minutes. Dr. Brewster remarks, "Light moves with a velocity of 192,500 miles in a second of time. It travels from the sun to the earth in seven minutes and a half."—Treat. Opt. p. 2. Mr. J. W. Herschel also mentions that "a ray of light travels over 192,000 miles in one beat of the pendulum of a clock."—Disc. p. 23. Yet La Place states that light employs 571 seconds in coming from the sun to the earth.—Vol. i. p. 168, 172. This makes the time nine minutes and a half, which is nearly one-third more than the usual calculation. This would greatly diminish the supposed speed of the descending light.

† Gen. ch. i. ver. 4, 5.

‡ Gen. ch. i. ver. 5. "And Elohim called the light day, and the darkness he called night." The VOLUSPA of the pagan North has a remarkable coincidence with this intimation:

The Sun knew not where should be his palaces:
The Moon knew not where should be her home:
The Stars knew not where would be their station.
Then all the Deities moved to their royal stools.
The stupendously holy Gods considered these things:
They *gave names* to the night and to the twilight;
They called the morning and the midday so;
And bade the rise and course of the year to begin.

Hist. Anglo-Sax. vol. i. p. 242, 5th. edit

space of time in which our globe turns once completely round. This section of time, which we subdivide into twenty-four parts, or hours, does not depend upon the sun, nor arise from it. As it is only an entire rotation of the earth, it could occur as well without a solar orb as with one.

The annual circuit, or a year, which is the completed orbit of the earth round this luminary, could not take place without a sun; but a day requires the existence and revolving motion of the earth alone. This is mentioned by Moses as beginning before the sun was made the centre of our astronomical system. As this fact denotes the diurnal movement to be distinct from the sun, and independent of it, it is another instance of the correctness of the Mosaic account. The first rotation of the earth round its own axis made the interval of the first day, and each subsequent revolution constituted the several days which succeeded.* Our planet might cease to turn round in this diurnal continuity, and might yet circle round the sun in its yearly course. The moon moves in this way about our earth; for it has no rotatory motion. The cause of our earth's revolving round its axis is quite distinct from the double and mutually counteracting forces which produce its annual orbit. Physics have not discovered, nor can rational conjecture assign, any reason for the diurnal rotation, except the commanding will and exerted power of the Divine Creator. Nor is it a mere revolution alone which makes our day; but it is a revolution with that particular, chosen, specifically assigned, and limited, and yet marvellous, velocity in which this movement is and ever has been performed. To occupy that portion of time which composes our day, it must move precisely, and with constant and undeviating exactness, at the rate of about 1000 miles an hour, or above 16 miles every minute,—a stupendous celerity for a massy globe nearly 8000 miles in diameter! A greater velocity would make

* The distinction between the day made by the time of the earth's rolling round itself, and that which is computed with reference to the stars and sun, is well known in science, and thus marked by La Place: "The *astronomical* day comprises the entire duration of the diurnal revolution; it is greater than the duration of a revolution of the heavens, which constitutes the *sidereal* day. Assuming the mean *astronomical* day to be equal to unity (1), the *sidereal* day is 0,997,26957."—La Place's System of the World, vol. i. p. 22. Mr. Harte's Translation.

our day so much the shorter; a slower progress would as much prolong it. But this revolving force has been continued and has acted for nearly 6000 years with a precision which has never varied. In all the ages of which history has preserved any memorial, the natural day has always exhibited everywhere the same uniform duration; a proof that the rolling power which actuates it has never undergone any alteration or diminution, but has still the same measured and governed proportion or agency with which it was first attached to our terrestrial habitation.*

It is desirable to refer all phenomena to natural causes, whenever these can be discerned, as it is unnecessary to resort to the Omnific Power, while his secondary instrumentalities are competent to the effect: but, for the performance and limitation of this amazing rotation no other origin can be alleged than the Divine choice and ordination. Of the other planets, three revolve round their axis in obedience to the same commanding potency, and in portions of time nearly similar; but the two largest ones, notwithstanding their greatly superior magnitude, in less than half that space.† And so might any have done. Our earth might have rolled round in twelve hours, or in twenty, or might have taken thirty or forty to have completed its rotation. For purposes unrevealed to us, but most probably in special adaptation to the nature, formation, and benefit of all the organized beings that have been created to be upon it, and particularly to the most salutary

* It was a great oversight in the theologians of the papal church to resist the admission of the Copernican system, that the earth moved round its axis, and to prefer to cling to the Ptolemaic theory, of the sun actually circling round us, as it appears to do. This old theory is incompatible with the Mosaic account, of a day beginning before the sun, because upon that, the sun is essentially necessary to make the period of time which constitutes a day. But on the Copernican system, the earth does this without the sun, as its revolving motion round its own centre, which forms our day, does not require the solar luminary.

† The planets Mercury, Venus, and Mars have a natural day, from their respective revolutions round their axis, nearly equal to our own, as Mercury performs his circle in 24 hours 5½ minutes, Mars nearly in the same time, and Venus in 23 hours 21½ minutes.—La Place, p. 53, 54, and note, p. 325. But vast as the force must be to revolve their masses in that time, it is inconsiderable to what Jupiter requires for effectuating his movement. His volume is 1,000 times greater than that of the earth, La Place, p. 62; and yet he rolls round his axis above twice as rapidly as our planet.—*Ib.* 68.

period of the sleeping and waking of its sentient existences, and to the fittest action and succession of light and heat, and their absence, we revolve as we do. It is as important to recollect these circumstances as it will be useful for our science to investigate their causes and effects, because one of the most satisfactory evidences to our admiring reason, that our earthly system is not a medley combination of accidents, but has been artificially composed and arranged by an intelligent Creator, on a wise and provident system of thinking, and according to a deliberate and designed construction, arises from that universal adaptation of all its parts and movements to each other, and to the fabrication, agencies, and welfare of the whole, which become the more manifest to our enlightened judgment the more they are studied and understood.

The use of the word "day," to signify in its lesser meaning that portion only of the natural day which occurs while one part of the earth is in visible light, was a secondary and peculiar application of the term, to express a different thing from that of our diurnal revolution. In this restricted sense, it rather shows the phenomenon of the illumination of our inhabited surface, than any specific lapse of time. The word is appropriated by us in popular language to mark the appearance as well as the duration of light in its perceptible state, as the term "night" denotes the period of its invisibility. An actual chronological day is thus made up of the alternation of darkness and daylight, whose respective durations are always so varying, that they never express any constant and equable recurrence or division of uniform time, which the natural day, caused by the rotation of the globe, steadily observes.

No account is given in Genesis of the geological formation of the different strata, rocks, and minerals which constitute the interior and the crust of the globe. The knowledge of these is left to be explored and ascertained by the researches and reasonings of our scientific inquirers. The intelligent curiosity of many, in every country of Europe, has been for some time, and continues still to be, directed to a minute examination of the mineralogical contents and geological structure of our globe, and with the most encouraging success. Surprising dicoveries have been made within the last fifty years; and that science,

which was in its babyhood in my youth, is now fast advancing to a state of vigorous maturity. The human mind has not shown its penetrating powers of research and inferential reasoning on any topic more creditably than on this. It has already disclosed many of the animals and vegetables of the antediluvian world; and has explored several important facts of the ancient state both of our surface and of the rocks and agencies immediately below it. The silence of the Mosaic record on the particular history of our geological construction allows free latitude to every speculation, and repels no philosophical investigator. It merely presents a few points and outlines, which nothing has yet occurred to disprove, although much has been observed, which it requires great talents, enlarged reasoning, and further knowledge to reconcile to them with precision, and to explain what may seem inconsistent. This, however, additional researches may be expected to effect; for it is probable that that theory will be found the truest, the most scientific, and the most satisfactory which is the most coincident with the Hebrew document. The Newtonian genius has, however, yet to arise in this department of our studies, whose capacious and penetrating mind can unite the facts and science of nature with this ancient and sacred record. His reward will be an intellectual immortality, like that of our greatest mathematician. The true system will accomplish this result. The Mosaic account does not expressly limit the process and the completion of the formations which compose our world, to that moment or that day in which the order was given for their occurrence. The issuing of the mandate marks the origin, and began the creation of what was commanded; but that specific operation having thus commenced, it appears reasonable to suppose that it continued to act as long afterward as was necessary for its effectuating all that it was intended to accomplish. Thus light was called into existence on the first day of the cosmogony. But having done on that day all that it was meant to effect in that period, we may assume that it continued to act afterward, during all the succeeding days, while subsequent commands set other agents and processes also into operation. Indeed it has been acting ever

since, as is daily manifested to our senses by the phenomena which it is still continually producing.*

This fact is shown by the next product of the creative energy which the Divine Wisdom was exerting—the formation of that aërial expanse which we call the atmosphere, and the elevation of a large portion of the watery element into the state of clouds and vapours, to float in the upper regions.† This operation divided the waters that belong to our earth into two portions, as well as into two states. The state of water in the seas is as dissimilar to its state in clouds, as if they were unrelated substances; vapour and water would not be imagined to be the same things, if we did not know their relationship to each other; but the quantity of each may not so greatly differ; for imagination can hardly conceive the enormous amount of this fluid which is always suspended or moving in the airy regions above us.‡ The atmosphere, under the old name of the firmament, divides these mighty masses of water from each other, pursuant to the Divine command. From the seas, rivers, lakes, rivulets, and moist earth it is ever ascending, by evaporation, into the atmosphere, to change again, and to fall down in dews, fogs, and rain.§ No agents are more active and efficient in transforming water into its vaporous state, than light and heat; and these also are essential parts of the common air of which our atmosphere is constituted. The atmosphere could not have been made before light had

* It is an opinion which phenomena of nature are continually occurring to strengthen in the observing mind, that light and heat have such close analogies and intimate relations with the effects and laws of the electric, magnetic, and galvanic fluids, as to induce a belief that they are all modifications of the same ethereal substance. If this be a just conclusion, the rise and action of light included the operation of all these fluids in the geological formations.

† "And Elohim said, Let there be a firmament, רָקִיעַ (expansion), in the midst of the waters, and let it divide the waters from the waters."—Gen. ch. i. ver. 6.

‡ Mr. Dalton has calculated the quantity of water which falls from the air in rain and dew in one year in England and Wales only, at 115,000 MILLIONS of TONS. Of this immense amount about one-third is carried off by the rivers and subterraneous cavities.

§ The same philosopher infers that 75,000 MILLIONS of TONS are yearly EVAPORATED into the atmosphere from the surface of England and Wales only. This quantity surprises us by its amount; but it is only half of that which will be noticed in Note p, 32, as Dr. Thomson's apparently well-founded calculation.

been connected with our globe; and the justness of the position of the formation of the atmosphere after the production of the light, and of the rise of the clouds after both these had appeared, is another instance of the rationality and truth of the Mosaic cosmogony.

The generation of the atmosphere and clouds occurred during another rotation of the earth, which formed the second day. It is scarcely possible to form an adequate idea of the quantity of water which, in the state of cloud or vapour, is always ascending into the atmosphere, and floating in it above us.* But here, again, another proof occurs to us, that our creation has been the product of an intelligent Mind, carefully adapting his provided agencies to the phenomena they were to cause, and these to each other; for unless the ascending vapours from both earth and sea had been duly balanced with the descending rain; and unless the fitted means were kept constantly in action, to occasion a constant evaporation, of sufficient amount to rise into the skies—and other effective causation, as unceasingly operating to make the elevated vapour descend in the needed showers, the vegetable and animal kingdoms would want that essential element, without which they could not subsist.† But the powers that are employed in

* The Mediterranean affords a striking instance of the quantity of water that ascends into the air above us. "The Nile, the Po, the Rhone, the Ebro, the Danube, the Nieper, the Don, and many other rivers of smaller extent, empty themselves into the Mediterranean, or into the seas connected with it, and constituting a part of this great inland ocean. Yet notwithstanding this great and regular influx of water, this sea not only *does not increase* in size, but a constant current sets in from the Atlantic through the Straits of Gibraltar—an evident proof that the *natural evaporation* from the surface of the Mediterranean is more than sufficient to dissipate all the water thrown into it from a vast tract of Europe and Africa."—Dr. Thomson's Outline of Heat and Elect. vol. i. p. 241.

† Dr. Thomson justly reflects, "Let us suppose for a moment that this spontaneous evaporation were to cease, and let us contemplate the consequences. No more rain or dew could fall; the springs would cease to flow; the rivers would be dried up. The whole water in the globe would be accumulated in the ocean; the earth would become dry and parched; vegetables, being deprived of moisture, could no longer grow; the cattle and beasts of every kind would lack their usual food; man himself would perish; the earth would become a dull, inanimate, steril mass, without any vegetables to embellish its surface, or any living creature to wander through its frightful deserts."—Outline, p. 200.

We may add, that as the whole water of the globe accumulated in

nature for this purpose must be stupendous in their agency; for when it is reduced to an arithmetical calculation, it overwhelms the conception by its surprising magnitude.* If light, with its modifications or companions, heat and electricity, be this operating instrument, it is an impressive indication of the wondrous potentialities of this surprising element, whose particles are stated to be so inexpressibly minute.

The next stage or process which distinguished the third revolution of the forming globe round its axis was the removal of the waters that were flowing over it, from its general surface, by the congregation of them into those united masses on portions only of its exterior plane, which we denominate seas.

> "Let the waters under the heaven be gathered together unto one place, and let the dry land appear."†

was the command; and the consequence was, that the watery element assembled on one portion of the earth into seas, while the rest of the earth became habitable ground. No detail is given of the causes or movements by which this mighty result was effected. Here also the geologist is left free to form his most scientific speculations. If the globular surface was a uniform level, with an equal diffusion of the waters upon its whole circumference, some parts must have been then raised up, in order to produce adequate concavities, into which the aqueous masses could subside and collect. The exterior form of the earth is manifestly of this kind. Vast ranges of mountains and rocks

the ocean, it would soon flow over the land and cover it again with a universal inundation. It is evaporation which now prevents the catastrophe of another deluge

* It has been calculated from careful observation that the annual *evaporation* from the surface of Great Britain, is equal to 32 inches of water. But the "mean fall of *rain* over all Great Britain cannot be estimated at less than 36 inches. Hence the evaporation is less than the rain by 4 inches. This excess must be supplied from the neighbouring seas. The 4 inches of rain not again elevated in the state of vapour must be annually carried into the sea by means of the different rivers. Now a quantity of water which would cover the whole surface of Great Britain to the depth of 4 inches would amount to 1,238,784,152,000,000 cubic inches, which is equal to 4,467,725,610,767 imperial gallons, or 17,729,069,844 tons."—Thomson's Outline, 268.

Hence eight times this enormous quantity ascends in vapour every year from our island, and nine times this inconceivable amount falls on it in rain.

† Gen. ch. i. ver. 9.

are now seen standing in various regions, as high above the common ground as the depths of the ocean seem to be below it in which the seas are permanently assembled. The surface of the earth rises, in some parts, into high table-land; but the general level of both land and sea is now nearly the same. The ocean is therefore obviously occupying cavities equal to its bulk of fluid; and the supposition seems to be not unreasonable, that, in order to form these hollow spaces, the mountain masses were raised up.* The state and phenomena of these stupendous elevations in many applicable points favour the idea, and recommend it to our consideration. But the Mosaic record has given no information on the subject, and therefore philosophy has from that, on this point, neither guide nor restriction in its theories or researches. It is only necessary that we should avoid all systems as erroneous which are incompatible with the other general intimations of this important document.†

* Dr. Young intimates the mean depth of the ATLANTIC Ocean to be about three miles; and that of the PACIFIC, four miles.—*Lect.* p. 47. But the European seas are less profound. "The greatest depth of the ADRIATIC, between Dalmatia and the mouths of the Po, is twenty-two fathoms."—Lyell's Geol. p. 236. The MEDITERRANEAN varies very much. Between Gibraltar and Ceuta, Captain Smith sounded 950 fathoms (1900 yards) to a gravelly bottom. Saussure, at Nice, to 2000 feet. In the narrowest parts of the Strait of Gibraltar, where they are nine miles broad, the depth varies from 100 to 500 fathoms (from 200 to 1000 yards).—Lyell, *ib.* p. 298.

LA PLACE infers "that the depth of the sea is inconsiderable. Its mean depth is of the same order as the mean heights of continents and isles above its level, whose height does not exceed 1000 metres (1093 yards). But as high mountains are spread over some parts of the continent, so there may be great cavities in the bottom of the sea."—La Place, Système, vol. ii. p. 116.

† That Moses was correct in representing the earth as first covered by the waters, before they were drawn off into the sea, is manifest from the admissions of those philosophers who are least disposed to favour his authority. Thus La Place mentions, "There cannot be the least doubt but that the sea covered a great part of our continents, on which it has left incontestable proofs of its existence. The successive subsidence of isles, and of a part of the continents, followed by extended subsidence of the waters of the sea, which have uncovered parts previously submersed, appear to be indicated by the different phenomena which the surface and strata of the existing continent present to us."—*Ib.*

De la Metherie expressed to De Luc, "Vous convenez encore *avec tous les physiciens*, que la surface du globe, à du être entièrement couvert d'eau dans la première origine." So Dolomieu says, "Limestone covers more than a third of our continents. It is the abundance of this rock, the

You will find it to be suggested by several able men, that the word "day," in the brief account of the creation in Genesis was not meant to be restricted to our duration of twenty-four hours; but was rather used as a term to express an indefinite period of time: and that six days of creation express only so many successive stages; and that each of these may be construed to be a thousand years; especially as in the Psalm which the Jews, according to an ancient tradition, supposed to be written by the same author, a thousand years are spoken of as no more in the Divine consideration than a human day.*

They have been led to this enlarged construction of the term, by finding many appearances in the state and nature of the masses of the earth, and of their organical remains, which, in the present degree of our geological knowledge, seem to have required a much longer period for their occurrence, and for the revolutions which they indicate our globe to have undergone, than the short space of six of our natural days would have admitted. Feeling this difficulty, they have preferred to expand the meaning of the word by which Moses designates the time of each successive act of creation, to the other alternative, of opposing his authority altogether. If there were an absolute necessity of making such an election, it would be most reasonable to coincide with their idea; and it is remarkable that some ancient nations had traditions of that sort among their learned men.†

position, almost always horizontal, of its beds, and the fossils it contains, which have taught us *the long residence of the sea* on our continents."—Journal de Phys. Oct. 1791.

M. Ferussac, less prejudiced, intimates the same fact, when he expresses the importance of showing "that the formations above the chalk were the production of a certain state of things intermediary between the *epocha when* the waters of the sea covered all, and when its surface became free."—Bull. Univ. 1828, vol. vi. p. 185.

So Werner thought "that the whole ocean must have formerly covered the whole earth at the same time."—Jameson's Mines, vol. iii. p. 75.

* "For a thousand years in thy sight are but as yesterday."—Ps. xc. ver. 4. St. Peter expresses a similar idea: "Be not ignorant of this one thing, that one day is with the Lord as a thousand years, and a thousand years as one day."—2 Pet. ch. iii. ver. 8.

† We learn from Suidas, that the ancient Etruscans had such traditions. He mentions that a well-informed man of their nation, who had written their history, stated, that God was the Demiurgos, or maker of all things; that he had employed 12,000 years in his creations, and had distributed them into twelve mansions. In the first chiliad, or 1000.

But although it is true that many of the geological phenomena have been represented by these observers, and others, to indicate that our earth has had a much longer duration than the strictest import of the terms used by Moses can allow, and especially in the succession of its organized races; yet, after the most patient comparison and consideration of their facts and reasonings, I cannot but feel that they have not at all advanced beyond plausible conjectures, as I also perceive that they are mostly at variance with each other; and that, as fast as one theory of this sort is set up, it has been found to be wrong by a succeeding inquirer, who attempts, in his turn, to establish a different one, of the same tendency, in its stead. These are all fair exertions of ingenuity, and arise from a desire to let no fallacy stand, and from a love of exploring what has baffled anterior research: but these circumstances prove, that none of these theories are true; that the right theory has not yet been discovered; that erroneous deductions have been made from the phenomena which have been seen; and that these are not yet justly understood, nor their real bearings discerned. Hence, I continue in the belief, that whatever is true in fact and correct in inference on this subject, will be in the end found to be not inconsistent with the account of Moses, nor with the common meaning of the expressions he uses. In studying the Scriptures, it is peculiarly desirable that we should on no occasion depart any more from the usual and natural meaning of the words and phrases which there occur, than we do in reading any other author. They have been greatly disfigured by the forced constructions which most men seek to put upon them; and much dissatisfaction has by this conduct been excited in the in-

years, he had made the heaven and the earth; in the second, the firmament, which he called heaven; in the third, the sea, and all the waters on the earth; in the fourth, the great luminaries, the sun and moon, and the stars; in the fifth, all birds and reptiles, fish and quadrupeds; and in the sixth, the human race. That being so formed, mankind would last 6000 years, and there would be a consummation of the whole world at the end of the 12,000 years.—Suidas, vol. ii. p. 958.

The ancient Persians taught the formation of things in this succession: the heavens, the waters, the earth, the trees and plants, the animals, and then man. The space they allotted to each period was in the following days; 55, 60, 75, 30, 80, and 75, making together 365 days, or a complete year, during which creation was completed.—Hyde Vet Pers. 164.

telligent mind. The true construction of every part must be, not the possibilities of meaning which refining ingenuity may draw from the expression, but that sense and purport which the author himself, in penning them, intended that they should express. His personal meaning at the time, and not the import which our verbal criticism can now extract, should be the great object of our attention. In the present instance, I think Moses meant to express six natural days; and therefore it appears to me to be most probable, that whenever the right theory on the fabrication of our earth, and on the era and succession of its organized beings, shall be discovered, it will be found to be compatible with the Mosaic cosmogony, in its most natural signification. But until this desirable event arrives, there will be as much incongruity between this ancient account and our modern speculations, as there cannot but be between the devious excursions of an active imagination, and the simple and solid, but unattractive, reality. Our German contemporaries, in some of their reveries on ancient history, are equally alert to prove that novelty of fancy is more sought for by many than justness of thought; that it is easier to argue than to judge; and that even truth becomes wearisome when it ceases to be original, and has lost the impression of its beauty by its habitual familiarity.

It is quite true that Moses did not profess to be a geologer, and had no business to be so. His object was, not to teach natural science, but to inculcate the existence, the laws, the will, and the worship of GOD; and to found the polity and social manners and institutions of his countrymen on this only true foundation of national prosperity and of individual happiness. But as he was the chosen organ of Divine truth to man, on his moral and religious duties, it is most probable that what he expresses on other subjects, in those compositions which were to be the permanent guides of the opinions and conduct of his nation, will be also what is true and proper. It is most consistent with all that we know of intelligent agency, to suppose that he who was instructed or guided to be the lawgiver and sacred preceptor of his people, would be likewise so informed, or influenced, as to avoid falsehood on every other collateral subject which it would be in the course of his narration to notice. If we were directing or assisting any pupil to

write on any topic, we should certainly not suffer him to insert any thing that we knew to be a fiction or a fallacy. It is, therefore, most rational to suppose that the same precaution was used by the Deity towards his selected messenger. Hence, I am induced to believe that what Moses expresses incidentally on other points besides those of his divine legislation is substantially true, and will be found to be so, as soon as his judges or readers have acquired competent knowledge. It is our deficiency in this which hurries us to discredit, or to doubt, or to oppose him. But on no collateral point, additional to his main subject, was he more likely to have been correct, either from true human traditions of preceding knowledge, or communications, or from new supplementary aid, so far as that was needed, than in his notices of the divine creation. This was indeed the true basis of his mission and tuition; and is brought prominently forward at once to our view, as if it were meant to be so. His brief intimations are, therefore, most probably the just outlines of all true geology; and thus far we may affirm, that the more our materials of judgment are increased by the multiplying labours of our geological students, the less founded any opposing speculations appear to become. It is now thirty-five years since my attention was first directed to these considerations. It was then the fashion for science, and for a large part of the educated and inquisitive world, to rush into a disbelief of all written revelation; and several geological speculations were directed against it. But I have lived to see the most hostile of these destroyed by their as hostile successors; and to observe that nothing which was of this character, however plausible at the moment of its appearance, has had any duration in human estimation, not even among the skeptical.

Augmented knowledge has from time to time overthrown the erroneous reasonings with which the Mosaic account has been repeatedly assailed; and has actually brought to light more facts in its favour than at this late period of the earth could have been expected to occur. Those which are of this description are enlarging in number every year; and therefore my belief is, that the veracity of the chief Hebrew historian will be ultimately found to be as exact in what he has recorded in the cosmogony with which he commences his work, as it is in the account of his own

legislation. There is certainly no appearance, as yet, that any contradictory theory will long survive its public enunciation. *Magna est* VERITAS, *et prevalebit*, is the everlasting axiom. Truth, and truth only, will obtain any immortality in the intellectual, and therefore in our literary and social world.

LETTER II.

On the Formation of our Planetary System—The Stars and the Comets.

MY DEAR BOY,

I HAVE preferred to lay before you this review of the sacred history of the world in the form of letters, because it will unavoidably be of that excursive nature which best suits this class of our literary composition. The peculiar events and agency, and the intelligent design that directs and causes them, which distinguish sacred from profane or common history, lead the mind to many considerations and investigations on which it desires to attain every elucidation which patient thought can supply. But these would not suit the direct statements and usual rules of historical writing, in its regular forms. The epistolary style will therefore be adopted, as most convenient for the accomplishment of the purposes of the present undertaking.

The fourth rotation of our globe was accompanied by the formation and arrangement of our planetary system. At this period of our creation Moses places the formation of the sun and moon, and their association with our earth; and expresses the divine order, that they should regulate the illumination of our world, and divide our day into the two natural distinctions of visible light and succeeding darkness, and become the cause of our seasons, and suggest and govern our computations of time.

> "And ELOHIM said, Let there be lights in the firmament of the heaven, to divide the day from the night; and let them be for signs, and for seasons, and for days, and for years: and let them be for lights in the firmament of the heaven to give light upon the earth: and it was so."*

* Gen. ch. i. ver. 14, 15.

It has not satisfied some that the sun should be supposed *not* to have existed before our earth; but why should an anterior subsistence be claimed for it more than for ourselves? There is no reason which makes it necessary that the sun or moon should have been framed at any other era, rather than at this period. We do not know, and we have no means of knowing, at what point of the ever-flowing eternity of that which is alone eternal—the Divine subsistence—the creation of our earth, or of any part of the universe began, nor in what section of it we are living now. All that we can learn explicitly from revelation is, that nearly 6000 years have passed since our first ancestor began to be. Our chronology, that of Scripture, is dated from the period of his creation; and almost 6000 years have elapsed since he moved and breathed a full-formed man. But what series of time had preceded his formation, or in what portion of the anteceding succession of time this was effected, has not been disclosed, and cannot, by any effort of human ingenuity, be now explored. It is an absurdity to talk of a beginning eternity, because that would be a contradiction in terms, and an inconsistency in idea, as far as such a boundless topic could be an idea within us. But yet, all existence and all time must have some relative reality with respect to each other. Creation must have begun at some early part of anteceding eternity; and our earth may have had its commencement in such a primeval era, as well as in a later one. We are approaching the six-thousandth annual revolution of our globe round the sun. This is all we positively know; but there is no compelling reason, which we can discern, why any thing should have been made earlier than our system. All are alike creations of the Creator, and therefore equal in dignity as to each other, and of equal estimation with him; and therefore the chronology of our being may be as ancient as that of any of the splendid orbs above us. But this is a point on which there seems no possibility of adding to our knowledge, by any exertion of the human intellect; all further information upon it must come from a superior source; and in the absence of this, the one supposition is as probable as the other.

But whatever may be the comparative antiquity between our globe and the myriads of radiant bodies which nightly

gem the immense expansion of celestial space above us, in their unaltering stations, the most natural idea, as to those which are linked with us in their concurring revolutions round our grand central luminary—and as to the sun himself, which attracts and governs both them and ourselves—and as to that pleasing satellite which makes our night so poetical and so beautiful,—is, that they and we had all one coinciding period of existence, and differ little in the chronology of our origin. This fact, at least, seems to be philosophically certain, that all the bodies which compose our planetary system must have been placed at one and the same time in that arrangement, and in those positions, in which we now behold them; because all maintain their present stations, and motions, and distances, by their mutual action on each other; neither could be where they are, nor move as they do, nor subsist as we see them, unless they were all coexisting: the presence of each is essential to the system which they constitute—the sun to them, they to the sun, and all to each other; and this circumstance is a strong indication that their formation was simultaneous, and therefore that the sun did not precede our earth in his formation, but was made as that was framing, just as Moses has narrated. Each of the planets, and the sun, have, no doubt, their several peculiar uses; but they have also been fabricated with mutual relations, and for common purposes. Our system of animated and vegetable nature could not subsist without the sun. We could not have our seasons, our daylight, or our years without him. He, therefore, has been made expressly for us, as well as for the substances and beings that he may contain within himself. He has equally been made for our sister stars, to whom he is apparently as indispensable as to us. The true chronology of these noble structures seems therefore to be, that the sun and the planets were formed while our earth was creating. The sun and moon for their uses to us, as well as for those to themselves and to the bodies that, with us, circle around them:—and this the Hebrew author intimates, when he adds—

"And Elohim made two great lights; the greater light to rule the day, and the lesser light to rule the night: the stars also."*

* Gen. ch. i. ver. 16. That the stars here mentioned were the planets

The stars with which we are connected are the six planets distinguished by the names of Mercury, Venus, Mars, Jupiter, Saturn, and Uranus; and those four smaller ones, discovered within the present century, and called the telescopic planets, because they are not discernible without the aid of a very powerful astronomical instrument; though, perhaps, instead of them, the more ancient one of which they are conjectured to be the wandering fragments, was the primeval companion of the other six.* The immense distance which separates the stars that belong to our system from the other unmoving ones, that shine in the infinity of space beyond, increases the probability that Moses alluded only to those with which our earth is concerned.† Of the creation of the rest, as they are no part of our cosmogony, but belong to other orders and systems of existence, with which at present we have no relations, no account is transmitted to us. They are indeed the most splendid mysteries of nature. They are known to us only as radiant points;

of our system, and not the fixed stars, seems a just inference, from the fact, that after mentioning them, Moses immediately subjoins, "And Elohim set them in the firmament of the heaven, to give light upon the earth, and to rule over the day and over the night."—ver. 17. Now the stars which were more peculiarly set in the firmament with direct relation to our earth, were the planets, two of whom are connected with our day and night, for Venus and Jupiter alternately become our morning and evening stars, and give a light to our earth in their transcendent brilliancy which no fixed star affords.

* These four minute bodies, if all were put together, would not exceed the magnitude of the moon; they are not larger than some of our islands. And Olbers has suggested, that they may be the fragments of a greater planet, which has burst by some explosive force. It has been calculated that an exploding velocity "twenty times greater than that of a cannon ball would be sufficient to make these describe orbits similar to those described by the other planets."—Harte, note to La Place, vol. i. p. 334. They are,

Ceres, discovered by Piazzi, 1800;
Pallas, in 1802, by Olbers;
Juno, in 1803, by Harding;
Vesta, in 1807, by Olbers.—La Place, p. 71.

They are so small, that Dr. Herschel judged the diameter of Ceres to be only 160 miles, and that of Pallas but 80. He called them asteroids.

† La Place gives an astounding idea of the distance of our system from the great host of the heavens; for he says, "Those stars which, from their great brilliancy, appear to be *nearest* to us, are at least 200,000 times farther from us than the sun."—Système, vol. i. p. 172. Dr. Wollaston reckoned Sirius, the beautiful star near the lower part of Orion, to be 525,481 times more distant from us than the sun. Dr. Bradley reasoned that γ Draco was 400,000 times the same distance.

for the most powerful telescopes cannot farther enlarge them;* and yet our scientific contemporaries are ascertaining that their number amounts to a multitude, which their predecessors never imagined, and which seems to exceed all our powers of fully exploring.† Of these it is remarkable that they are undergoing changes for which we have no means of accounting, but which display mighty causes to be there in active operation.‡ Sometimes the alterations are gradual, and observable by human care, though not explainable by the acutest minds of science.§ Sometimes they indicate an actual destruction.‖ It is one of the won-

* La Place, vol. i. p. 80.

† "Mr. Bessell, of Königsberg, observed in three years between 30,000 and 40,000 stars comprehended within a zone extending 15 degrees on each side of the equator; but even this great number is but a small portion of the whole within the limit of the zone which he examined. To procure a more complete survey, the Academy of Berlin proposed that *this same zone* should be parcelled out among twenty-four observers, and that each should confine himself to an hour of right ascension, and examine it in minute detail. This was adopted; and the eighteenth hour was confided to Professor Inghirami, of Florence, and examined with so much care, that the positions of 75,000 stars have been determined in it."—Edin. Rev. May, 1830, p. 91.

If this number was ascertained to be in one part only out of twenty-four, the amount in the other twenty-three positions of this zone, and in the rest of the heavens, will reach a magnitude that makes the Divine promise to Abraham not a mere emphatic simile, but an exact comparison. "Look now toward heaven, and tell the stars, if thou be able to number them: so shall thy seed be."—Gen. ch. xv. ver. 5. If the nebulæ that abound so much above are truly resolvable into clusters of stars, the multiplicity of these radiant bodies is indeed, at present, innumerable.

‡ Thus, "a new and brilliant fixed star was *twice extinguished* during Galileo's life. The temporary star in Cassiopeia, observed by C. Gemma in 1572, was *so bright* as to be seen at noonday. That in Serpentine, first seen by Kepler in 1604, exceeded in brilliancy all the other stars and planets."—J. W. Herschel's Discourse, p. 115.

§ La Place observes of the Cassiopeian star, "In a short time it surpassed the most beautiful stars, even Jupiter himself, in brilliancy. Its light afterward grew feeble, and in sixteen months after its discovery, it disappeared, without having changed its place in the heavens. Its colour experienced considerable variations; it was first of a dazzling white, afterward of a reddish yellow, and lastly of a lead-coloured white. What was the cause of these phenomena?"—Système, vol. i. p. 81.

‖ The idea of La Place is reasonable: "As to those stars which suddenly shine forth with a very vivid light, and then immediately disappear, it is extremely probable that great conflagrations, produced by extraordinary causes, take place on their surface. This conjecture is confirmed by their change of colour, which is analogous to that presented to us on the earth by those bodies which are set on fire and then gradually extinguished."—Système, p. 81.

ders of creation, that any phenomena of bodies at such an immense distance from us should be perceptible by human sight; but it has clearly been a part of the Divine maker's plan, that although they do not act physically upon us, yet that they should be so far objects of our consciousness as to expand our ideas of the vastness of the universe, and of the stupendous extent and operations of his omnipotence. By them we are enabled to ascertain that existing space expands around and beyond us for millions of millions of millions of our earthly miles; and that his creations accompany and abound in all this marvellous extent, which, displaying no boundary, no terminating ends, may be justly called infinite. It is an ocular reality, which gives us a sensitive idea of actual infinitude; for it presents, to every examining eye, extension spreading into ubiquity, and nowhere reaching any visible or inferable limit. The immeasurable expansion of the heavenly regions, illustrated to our sight by the splendid spheres which mark the amazing extent, is therefore, in the strictest meaning of the term, a manifest INFINITY,—an infinity made visible to our intellect by immense distances which our eye can survey, and which, from what is seen, compel the judgment to perceive and infer an unbounded universality beyond them: for there is nothing in them which denotes that what reaches our sight in them is at the last limits of existing nature.

These lofty mansions of being also indicate to us, that they have the same Creator as ourselves, and are but so many other magnificent scenes of his sovereignty and care. For they display an abiding relation of position, and a similarity of motion and of nature, which philosophers have noticed,* and there are strong indications of unity of design and creation. But their very appearance exhibits such a congeniality and analogy of nature with the radiant bodies

* "The fixed stars preserve an invariable position relatively to each other. There is in all the stars a general periodical motion, which produces a slight change in their respective positions, which is called aberration. Several stars have proper motions peculiar to themselves, very slow; but which the lapse of time has rendered sensible. Hitherto, these have been principally remarkable in Sirius and Arcturus, two of the most brilliant; but every thing induces us to think that in succeeding ages, similar motions will be developed in the other stars. . . . It is extremely probable that the nature of all these stars is the same."—La Place, Système, p. 88 and 81.

which form our system, and especially in possessing and imparting the same luminous fluid which we enjoy, that the reason cannot but refer all the stellary orbs in the celestial spaces to one common Author. The identity of the light, which alike emanates from all, precludes all rational doubt on this interesting question. That our light was his creation we learn from his Scriptures. This fact justifies us in referring it in other orbs to the same origin; and nothing in the universe shows any marks of any other creative power.

The facts of nature are sometimes so surprising as to be incredible to any but a scientific mind. One of these is the circumstance, that those fixed stars, in their immense remoteness from us which occasions their parallax to be insensible, should yet be visible to our eyesight, especially when the portion of their light which reaches us is so inconceivably small. That light, the most attenuated fluid we know, whose particles have the incomprehensible minuteness which was mentioned in the former Letter, should travel in undeviating straight lines through so many inexpressible millions of miles, and reach our comparatively petty globe, and enter every eye upon the surface which looks towards them,—is one of the miracles of our created nature. But this effect becomes the more surprising, when philosophers of great caution and high reputation present to us their computations of the comparative smallness of the degree of the luminous fluid which from them affects our visual organs.*

The great host of heaven, technically called the fixed stars, have other analogies to our system, which confirm the belief that they originate from the same creative Power, though in a different, and to us unknown, chronology; but which makes the epithet of fixity in some degree an erroneous denomination. Though appearing to our unassisted eye as single stars, some are not so, but are a combination of several. One has been ascertained to be a sextuple star, or

*Dr. Wollaston inferred the sun's light to be 11,839,530,000 times greater than that of Sirius; and if we suppose that the sun lost half of his light by the reflection, then that of Sirius, one of the brightest stars we know, is not one 20,000 millionth part of the solar light. But that of the smaller star Vega, he computed to be only one-ninth part of the light of Sirius, or 180,000 million times less than that of the sun.—Ferussac. Bull. Univ. Sept. 1830, p. 182. Yet it is visible to us.

six associated together;* two others are quadruple, or groups of four;† several are triple;‡ and still more are double.§ This resembles our earth and the moon, and the other planets with their satellites. This similitude is increased, by our finding that they revolve round each other, or round a common centre, as we and our companion move round the sun. Another analogy may be traced in the colours of some; for one of the stars is white; Aldebaran is a glowing purple;‖ Scorpio is red, like our Mars. It also

* Sir J. South notes the σ of Orion to be of this kind. The first of the six being 8½′ from the principal, which is of the fifth magnitude.

† As the ζ of Perseus, and α of the twins in Castor. Two of these four are very near, and form a system; the two others are above 3′ distant. —Sir J. South in Ferussac, 1827, vol. ii. p. 102.

‡ The γ in Leo is triple, and two of them form a system. The same may be said of ε Bootes, ξ Scorpio, and σ Northern Crown.—*Ib.* Sir James also mentioned, in this paper, to the Royal Society in 1815, that all the three stars of the triple star ζ Cancer were ascertained to be relatively in motion, and described orbits about each other. He and Mr. Herschel remarked in 1824, of the triple star Lynx 12, that two of them were very near; that they had manifestly altered their distance, and yet the farthest of the three had not sensibly seemed displaced. Their angularity movement is 22° in forty years, which announces a complete revolution in 656 years. In fifty-seven years the three stars would be in a straight line.—Phil. Trans. 1824. Part 3.

§ The same gentleman remarked, that a great number of other stars were double, and presented also angular movements, which indicated revolutions round a common centre; as θ and γ of Virgo, ξ of Bootes, η of Cassiopeia, 32 of Orion, δ Serpent, ρ Ophiucus.—*Ib.* . . . . In the double star ξ Great Bear an angle of nearly 14° was found to have been described by the two stars about their common centre of gravity in less than two years. It was M. Struve, of the Dorpat University, who first observed this important phenomenon, which implies that these two stars form a system. In 1826, with one of Frauenhofer's large refracting telescopes, this professor surveyed 1000 double stars of the first four classes: 800 of these were then new to science, and 300 of them of the first class. This indefatigable man, continuing his labours, has examined above 120,000 stars, and found 3060 to belong to the first four classes of double stars, of which in 1820 he had only seen and catalogued 500.

‖ The colours of the stars are curious and beautiful phenomena. The instances specified by Mr. Barker in August, 1831, will give some idea of them:—*a* Hercules a double star: the large star red; the small of a bluish-green colour.—ζ Hercules: the large star bluish-white; the small of a fine ash colour.—β Lyra a variable star: three of the combinations are white; the fourth of a red colour.—v Cygni a triple star: the large are white; the others red.—γ Andromeda: the large star red; the smallest sky-blue.—Near 21 Persei is a double star: the large one yellow; the small blue.—Near the feet of Aries is a double star: the largest of an intense ruby colour; the small one green.—*Uranus* appears like a star of the fifth magnitude, with a bluish-white light. The asteroid *Pallas* shines with a faint rosy tint.—Lit. Gazette, No. p. 554.

appears in the changes and in the brilliance of many, which is a variation that has been remarked in some of our planets.* There is also the grand analogous circumstance, that as all the planets move from west to east in their rotations and orbits, so the whole body of the stars appear to have a general movement in the same direction, which some have computed to be completed in 25,000 years.

The creation of the fourth day, being considered as confined to our own system, embraced the sun, moon, and connected planets, and may be considered as extending to their composition and allocation. Let us briefly recollect the leading circumstances of this important formation.

Of the actual substance of the SUN, so little, satisfactory yet to our judgment, has been discovered, that all which is mentioned concerning it, can rank no higher than conjectures of scientific imagination more or less plausible. The comparative masses of its spacious substance, and of the other planets, have been calculated.† Dr. Herschel thought its body to be opaque, with an upper stratum of self-luminous clouds. Black spots, of varying magnitude and form, are continually appearing upon it, and receding; and have led astronomers to discover that the sun has a rotation round its own axis, which it performs in about twenty-five days and a half.‡ These spots are almost always comprised in a particular zone of its surface.§ His diameter has been

* La Place mentions of Venus that it becomes at times so brilliant as to be seen in full daylight with the naked eye. The greatest brightness returns after an interval of eight years.—P. 54. Above thirteen stars are known to be changeable in this respect. The increase of light has been found to occur more rapidly than its diminution.

† La Place states the following proportions to exhibit the relative masses of the planets; that of the sun being taken as unity:—

Mercury	$\frac{1}{2,025,810.}$	Mars	$\frac{1}{2,546,320}$
Venus	$\frac{1}{405,871.}$	Jupiter	$\frac{1}{1,070,5.}$
The EARTH	$\frac{1}{354,986.}$	Saturn	$\frac{1}{3,512.}$
		Uranus	$\frac{1}{17,918.}$

Système, vol. ii. p. 42.

‡ La Place, vol. i. p. 19.

§ *Ib.* p. 20. One of the largest spots for some time seen upon the sun

estimated to be 886,149 miles. From the faint zodiacal light which at times accompanies it, an atmosphere has been ascribed to it, but so thin that stars are visible through it.* The variety of seasons which it was appointed to produce is caused by the inclination of the ecliptic to the equator.†

The substance of the MOON is more known to us than that of the brighter luminary. Its volume is forty-nine times less than the volume of the earth.‡ There is ground for supposing that all is solid at its surface, for it appears, in powerful telescopes, as an arid mass, on which some have thought they could perceive the effects, and even the explosions, of volcanoes.§ There are mountains on the surface of the moon which rise to the height of nearly two miles; and it has been inferred that it has deep cavities, like the

was on 30th June, 1830. The diameter subtended an angle of 57″. It was then calculated, that taking the sun's diameter at 800,000 miles, it extended 23,750 miles in length, and being nearly circular, would in that case have covered 443 millions square miles of the sun's surface. The greatest magnitude of spots mentioned by La Place is four or five times that of the earth.—P. 19. "The nature of these spots is yet unknown."—*Ib.*

* La Place, p. 20. Dr. Herschel has inferred, that what he deems the sun's luminous atmosphere is 2,500 miles from its surface.

† *Ib.* p. 8. If this obliquity were to be altered, and the ecliptic to be made to coincide with the equator, it is supposed that our animal and vegetable species, as now constituted, would be destroyed, and the human race, in their present state, be unable to subsist. Condamine reckoned, that in 1755 this obliquity was less than in 1510 by 1′ 16″.—Tour to Italy. And it is now calculated to be 23′ 47″ less than it was in the time of Eratosthenes, decreasing a small quantity every year.

‡ La Place, p. 35.

§ La Place, p. 42. "This surface seems to show traces of volcanoes; and the formation of new spots and the sparke which are observed in its obscure parts appear to indicate volcanoes in actual operation."—*Ib.* p. 47. . . . The aerolites, or great stones that fall occasionally from the air, are either consolidated in the atmosphere, or come to us from the moon, which many philosophers think probable. Mr. Harte calculates, that a body projected from the surface of the moon with the velocity of 6000 feet in a second would be carried beyond the attraction of its mass as now ascertained; that is, a force capable of projecting a body a little more than a mile and a half in a second. But cannon-balls have been propelled half a mile in a second. Therefore a projectile force three times greater than that of cannon would move a body from the moon beyond the point of equal attraction, and cause it to reach the earth. But a force equal to this is often exerted by our earthly volcanoes and subterraneous steam.—Notes to La Place, vol. ii. p. 429. Hence, there is no impossibility of their coming from the moon; but yet I think the aerial consolidation more probable.

basins of our seas.* Caspian lakes have been supposed in it.† But it has either no atmosphere, or it is of such extreme rarity as to exceed the nearest vacuum we can produce by our best constructed air-pumps; so that no terrestrial animal could breathe alive upon its surface.‡ If, then, it be inhabited, it is not by beings who have bodies like either men or any of our animated races. The lunar population must be of a far more aerial nature than our present selves, or our most delicate fellow-creatures. Only sylphs, spirits, or angels suit such ethereal medium. It has a great number of invariable spots, which prove that the moon always presents to us the same hemisphere, and revolves on its axis in a period equal to that of its revolution round the earth.§ Its dark and bright parts have given rise to the idea that it has seas, islands, and continents; but it is now doubted whether it has any water at all; and it has been supposed that if it had any oceans, the superior attraction of the earth, especially when in conjunction with the sun, would draw the aqueous fluid into a deluge over a large part of its surface. The light of the full moon is at least 300,000 times more feeble than that of the sun.‖ From this inferiority, the lunar rays, when collected in the most powerful mirrors, produce no sensible effect on the thermometer.¶ Indeed, they seem to have a cold-producing agency, according to the experience of practical men, though philosophers have not yet ascertained the fact by their direct experiments.** That

* La Place, p. 47. An American astronomer has imagined that it was covered with ice and snow.

† Ferussac, Bull. Univ. 1830, p. 162. Mr. Olbers thinks that Lohrman's Chart of the Moon surpasses all others that we have of it.

‡ La Place, p. 42.

§ La Place, p. 43. It is inferred, that from this mode of movement one half of its residents never see our earth, and the other half never behold the sun. In every month they have only one day and one night, each a fortnight long.

‖ This is Mons. Bouguer's inference, from his experiments, which La Place inserts in his work, p. 42. But Dr. Wollaston has thought himself justified, from his comparisons, to conclude that the light of the sun is almost a million of times greater than that of the moon. He computed the solar light to equal that of 5,563 candles placed at twelve inches distance, and the light of one of these, at this distance, to correspond with that of 144 moons. He therefore inferred the sun to exceed the moon in brilliancy 801,072 times.—Feruss. B. U. Sept. 1830, p. 179.

¶ La Place, p. 42.

** M. Arago was assured by the gardeners of Paris, that in the months of April and May, they had found the leaves and buds of their plants,

they have a peculiar and unsalutary influence on the animal frame appears to have been actually experienced by some of our countrymen.* Other nations declare the same.† It has been so often observed in mental derangement, that this malady has been named lunacy, from the assumed effect; and medical men, experienced in such cases, have assured me that in many there is a visible excitement at the changes of this luminary. Its atmospherical effects have been also asserted.‡ We learn from Plutarch, that the ancients believed the moon to produce many singular results, which he enumerates.§ Hence, however beautiful and interesting the

when exposed to the full moon in a clear night, actually frozen, when the thermometer in the atmosphere was many degrees above the freezing point. He mentions that these facts indicate the moon's rays to have a frigorific power; but that the largest speculums directed to the moon produced no such indications on a thermometer placed in their focus.—Ferussac. Bull. Univ. 1827, p. 383.

Dr. Howard, of Baltimore, has affirmed, that on placing the blackened upper ball of his differential thermometer in the focus of a thirteen-inch reflecting mirror opposed to the light of a full moon, the liquor sunk in half a minute eight degrees!!

* "Men on board a ship, while lying in the moonlight with their faces exposed to the beams, often have their muscles spasmodically distorted, and their mouths drawn awry; others have been so injured in their sight as to lose it for several months." "Fish hung up all night in the light of the moon, when eaten next day, has occasioned violent sickness and excruciating pains."—Montgom. Travels of Tyerm and Bennett. The Baptist missionaries mention that he who has slept in the moonlight is heavy when he awakes, and as if deprived of his senses. This corresponds with what Plutarch notices: "Everybody knows that those who sleep abroad under the influence of the moon are not easily waked, but seem stupid and senseless."—Plut. Symp. l. 3. I have felt this.

† Mr. Madden mentions, that the Arabs attribute a morbific influence to the moon, and think it causes ophthalmia and catarrh. He thought there was some influence from it in the desert, beyond the common dampness of the nights.—Travels in Turkey.

‡ M. Flaugergues declares that for nineteen years he found a constant relation between nebulous days and the phases of the moon.—Bull. Univ. 1829, p. 69.

§ Plutarch's notices are:—"The moon has some influence on flesh; meat corrupts sooner in the moonlight than in the sun—nurses are cautious of exposing their infants to the moonbeams—women brought to bed at full moon have easy labours—hence Diana, or the moon, was made the goddess of childbirth; and Timotheus says, 'And by the moon, which lessens the pains of women'—the carpenters refuse trees cut in the full of the moon, as softer—farmers usually thrash their wheat in the wane; it is then drier, and bears the flail better; in the full, it is moist and bruised—dough leavens sooner in the full—at this time most dew falls. Hence the poet Alcman calls the dew the daughter of the air and of the moon."—Plutarch's Sympos. lib. iii. quest. 9. I observe that

moonlight scenery of both heaven and earth is felt to be by all, it will be always wise to recollect, that the night is our natural and appointed season of retirement and repose.

But our system could not be completed to be what it is without the other planets. These are the six larger ones, and the four asteroids, which move in circuit round the sun, like ourselves; and the satellites which are found to revolve round the three most distant planets.

The ten planets and asteroids are always visible, except when immersed in the solar rays. The first five have been known from the remotest antiquity, because they can be observed by the natural eye: but Uranus and the asteroids remained unknown till the telescope descried them since the middle of the eighteenth century.* Mercury and Venus never recede from the sun beyond certain limits. The others are elongated from it to all possible angular distances. But the motions of all these bodies are comprehended in a zone of the celestial sphere, called the zodiac; and the breadth of this is divided into two equal parts by the ecliptic.†

MERCURY, so near to the sun, and thence so heated, that Dr. Walsh has not unaptly said, the inhabitants, if any, must be so many animated basaltic Memnons, revolves round its axis as we do, and in the same time.‡ Being commonly immersed in the sun's rays in the evening, and thus continuing invisible till it emerges in the morning, it appeared like two distinct stars; and a long series of observations was requisite to enable the student of the heavens to recognise the identity of the star which was seen to recede from the sun in the morning, with that which approached it in the evening; but as the one was never seen until the other was invisible, it was at last concluded that it was the same planet which oscillated on each side of the sun.§

Mr. Edmonstone, who had lived thirty years in the forests of Demerara, remarks that trees cut in full moon split, and the wood soon rots.—Bull. Univ. 1830, vol. vi. p. 162.

* Mr. Flamstead, in 1690 and afterward, had noticed and registered Uranus as a star; but no one was aware that it was a planet till Dr. Herschel made the important discovery which has given the largest extension to our system that it is now known to embrace.

† La Place, vol. i. p. 48.

‡ Schroeter thought this was done in 24 hrs. 5′ 30″.—Mr. Harte's note to La Place, p. 325.

§ La Place, p. 50. Its elongation from the sun never exceeds thirty-two degrees.—*Ib.* 48.

VENUS revolves, like our earth, in somewhat less than a day.* Schroeter has inferred from his observations, that it has mountains of a considerable height, and is surrounded by an extensive atmosphere, whose refracting power does not differ much from our own.† It may therefore have inhabitants more like ourselves than those of the other planets, but it is much hotter than our globe, even in our torrid zone. It surpasses all the celestial orbs in its brilliancy. It appears sometimes with horns, like the moon.

MARS, distinguished by the redness of its colour, does not move exactly in the plane of the ecliptic. It sometimes deviates several degrees from it. It changes its apparent form, and becomes sensibly oval, according to its position with respect to the Sun; which shows that it receives light from this luminary. From the spots that have been noticed on its surface, it has been inferred that it revolves in rather more than our day on its axis, inclined to the ecliptic in an angle of 66° 33′. Its polar diameter is somewhat less than its equatorial.‡ In this it resembles also our earth.§

The splendid orb of JUPITER, though above twenty times larger in diameter than our globe, yet has received such a far greater acceleration of agency than was appointed to our planet, that he revolves round himself in less than half our day.‖ His diurnal circuit gives him five hours daylight and five hours night; but his circuit round the sun is so ample, and his ratio of motion so different from ours, that he takes nearly twelve of our years to complete it. His season is supposed to be uniform.

* Schroeter found this to be in 23 hrs. 21′ 29″.

† La Place, p. 53.

‡ La Place, p. 56. Arago measured these diameters to be in the ratio of 189 to 194.—*Ib.* p. 57. His sidereal revolution is 687 days; his synodical 780.—*Ib.* p. 54.

§ In our globe "the excess of the radius of the equator above that of the poles does not surpass 20,000 metres."—La Place, p. 116. Not quite twelve miles and a quarter. M. Poinsot asserts that this flatness of our globe at the two poles, though very small, is sufficient already to derange our equator every moment; as we perceive in the heavens by the sensible phenomenon of the procession of the equinoxes.—Bull. Univ. May, 1830, p. 336. Newton first inferred this polar flatness.

‖ La Place, p. 162. The motion of his spots indicates his rotation to be from W. to E. in a period of 0,41077 decimal of a day.—P. 59. "His volume is 1000 times greater than that of the earth."—*Ib.* p. 63. His semi-diameter is to the earth's equator as 291″ 185 is to 26″ 541.—*Ib.* ii. p. 44.

Jupiter was made to be the most brilliant of the planets after Venus, which he sometimes surpasses in brightness; though he is at least five times more remote from us than the Sun.* Like Mars and our globe, his orb is flattened at the poles.† Four small stars, or satellites, constantly accompany him, always changing their relative positions. The magnitude of these moons cannot yet be exactly measured;‡ nor have the several obscure belts which are observable upon his surface been as yet accounted for. To his inhabitants the sun is supposed to appear but as a bright star, giving little or no sensible heat.

SATURN was placed about nine and a half times farther from us than the sun; and made to revolve round his axis, like Jupiter, in less than half of our day; though his mass is so much greater than ours. His celebrated ring was found by Herschel to have a similar rotation, in nearly the same time.◊ Although so remote from the sun, both his body and his ring are deemed opaque bodies, illuminated by it. The ring disappears when the earth is in its plane, as its thickness is imperceptible, and it becomes also invisible when the sun is in its plane, and continues so as long as that plane is between the sun and the earth.‖ "Its seven satellites revolve around it from west to east, in orbits nearly circular—the first six almost in the plane of the ring, while the orbit of the seventh approaches more to the plane of the

* La Place, p. 59, 62.

† Arago found by a very accurate admeasurement that his polar is to his equatorial diameter very nearly in the ratio of 167 to 177.—La Place, p. 59.

‡ Herschel observed, that these satellites surpassed each other successively in splendour, and ascertained that they revolve on themselves, like the moon, in a period equal to the duration of their revolutions round Jupiter.—La Place, p. 63. This circumstance makes them very like our moon. "The inequalities produced by their mutual attraction do not differ materially from those of the planets and of the moon."—La Place, vol. ii. p. 82. This great astronomer has even computed their respective masses, though their extreme smallness, and the impossibility of measuring their diameters, seemed to forbid such an attempt.—See them stated, p. 88. He explains, with elaborate science, their inequalities in the Second and Eighth Books of his Celestial Mechanics.

◊ The planet in 0,428 of a day; the ring in 0,437.—La Place, 68, 67.

‖ La Place, p. 65. Yet by increasing the power of the inspecting telescope, Herschel found that it remained visible to him, after it had disappeared to other observers.—*Ib.* p. 66. . . . . "From several black bands which have been observed by some astronomers, it would appear that there is a greater number of these rings."—*Ib.* p. 67.

ecliptic. Herschel traced five belts upon its surface, nearly parallel to its equator.*

With the orbit of Saturn our solar system had been always thought to terminate, till Dr. Herschel, on the 18th March, 1781, ascertained, that vast as his circuit was, yet that it embraced only half of that area of space which it really includes, by discovering a new planet to be revolving at twice the distance of Jupiter from the sun. This grand addition to our system was at first named Georgium Sidus, then Herschel, and now more commonly Uranus, especially on the Continent. It moves with a slower ratio of speed from west to east, and forms by its orbit the present confines of our planetary system. Its apparent diameter is very small. Herschel discovered six satellites to revolve about it, in orbits nearly circular; but only telescopes of very high magnifying power enable us to perceive them. Two only have been recognised and fully admitted by other astronomers.†

The asteroids, or telescopic planets, that revolve between Mars and Jupiter need not be further noticed here than to mention their apparent confirmation of the new law which the scientific Bode had suggested; or, to speak more correctly, his recent perception of an ancient law; for what is novelty to us is antiquity to nature. His idea was, that the several planetary orbits have a progression in their magnitude. But this law seemed to be interrupted between Mars and Jupiter. Hence he inferred, that there was a planet wanting in that interval;‡ a bold yet profound conjecture; but this predicted deficiency is now found to be supplied by the four new asteroids, which occur in the very space where the unexplained vacancy presented a strong objection to the theory. All their orbits conform in dimension to the law in question.§ Thus the deduction

* La Place, 68, 69. "Saturn moves in his orbit more than 22,000 miles an hour."—Herschel, Disc. p. 192.

† Hence, La Place thinks we cannot yet be incontrovertibly sure of their existence.—P. 70.

‡ His perception was, that the planetary distances above Mercury form a geometrical series, of which the common ratio is 2: each orbit in ascent being double the distance of the next inferior one from that of Mercury. Thus Saturn revolves at twice the distance of Jupiter, and Uranus at twice that of Saturn; but between Jupiter and Mars the law seemed to fail.

§ J. W. Herschel's Discourses, p. 308.

of Bode was ascertained to be one of those predictive anticipations of true science which, if just, are, like Newton's inference of the combustibility of the diamond, sure to be verified by the subsequent accessions of our philosophical knowledge. These asteroids move at half the distance of Jupiter, and at twice that of Mars, from Mercury. This establishment of such a law furnishes another impressive instance of the scientific plan and principles on which creation has been fabricated. Every new perception of the intelligent laws by which the heavenly bodies move and are regulated makes more palpable the impossibility that they can have occurred from any other origin than that of a designing, conceiving, selecting, and ordaining cause—a real, pre-existing, intellectual Creator. Such wonderful science, so exactly, so efficaciously, and so permanently operating, can never have arisen from mere confusion, from random motivity, or from irrational chance.*

Such was the celestial system with which our globe was associated at its creation, distinct from the rest of the starry masses. But you will observe that the COMETS have not been mentioned as a part of it, and may be disposed to ask, whether they were among the heavenly bodies that were of a contemporary formation with our earth. It is a natural inquiry; but we have no materials on which we can satisfactorily reason to any useful conclusion on this point. Although we have now become acquainted with so many, we know but little about them. They participate, like the other stars, in the movement of the heavens; and this, combined with the smallness of their parallax, proves that they are not meteors generated in our atmosphere. Their proper motions are extremely complicated. They have a place in every direction; and are not restricted, like the planets, to move from west to east, and in planes very little inclined to the ecliptic.†

* Their fulfilment of Bode's law strengthens the probability that they are the fragments of a single planet which once moved in the same orbit in its solid integrity, as this substantial singularity would more resemble that of the others. The three first of the asteriods take four years and eight months in their sideral revolutions, but Vesta a year less. "Pallas deviates from the plane of the ecliptic considerably more than the other planets. So that to compute its deviations, we should enlarge considerably the breadth of the zodiac."—La Place, p. 71.

† La Place, p. 79. "Nearly one half of the comets move from west to east, while the other half perform their movements in a contrary direction."—Quart. Rev. No. 41. p. 317.

If we knew their uses in our system, we could form more probable conjectures as to the chronology of their creation. They have been noticed from the earliest era of astronomical history; and if our modern philosophers had not discovered that some, at least, leave us to return again into our system, and therefore describe a vast elliptical orbit round our sun, we might have fancied that the periods of their first recorded appearances in our field of science were the eras of their individual formation. But their recurring presence proves that their first existence ascends into unexplored and unrecorded antiquity. Yet from whence they come to us we as little know, as for what purpose. Tycho Brahe proved that they were farther from the earth than the moon, and were nearly as distant as the planets. The comet of 1682 reappeared in 1759, having in the interval described an orbit like an ellipsis, answering to a revolution of 27,937 days. It will therefore reappear in November, 1835, or four years hence.* In its greatest distance, it is supposed not to go above twice as far as Uranus. This is indeed a prodigious sweep of space; and it has been justly observed, that the vast distance to which some comets roam proves how very far the attraction of the sun extends; for though they stretch themselves to such depths in the abyss of space, yet by virtue of the solar power they return into its effulgence. But it has been recently discovered that three comets, at least, never leave the planetary system. One, whose period is three years and a quarter, is included within the orb of Jupiter; another, of six years and three quarters, extends not so far as Saturn; and a third, of twenty years, is found not to pass beyond the circuit of Uranus.†

* M. Pontecoulant, in Bull. Univ. 1830, p. 330. "It experienced in its course perturbations from the planets Jupiter, Saturn and Uranus, and a sensible alteration from the action of the earth."—*Ib.* He calculates these perturbations. It had appeared before, on 25 Aug. 1531, and 26 Oct. 1607; then on 14 Sept. 1682, and 12 March, 1759. He expects it on 7 November, 1835; but M. Damoiseau thinks it will be the 4th of that month.—*Ib.* [A fair bet for betting fancies.] With such authentical precision do men of science attempt to anticipate the movements of these immensely distant, and usually invisible bodies.

† Mr. J. T. Barker, Buckardt, and La Place have calculated and shown the effects which the action of Jupiter's attraction has had on some of the comets. It may have rendered the one of 1770 then visible, which had been unseen before; and have made it invisible again from the year 1779.—Mechan. Celest. ii. p. 236

The little comet, the first of these three, whose returns were predicted and its orbit ascertained by Encke, cuts the orbit of four planets in its path. Approaching within the distance of Mercury, it recedes to about four-fifths of that of Jupiter. Its body seemed without a nucleus, or any regular, defined form. Stars were seen through it. It is attached to our system, and describes equal areas round the sun in equal times.* Its figure was circular, approaching to an oval, without any appearance of a tail. This fact evinces such relations to our system, that if any comet can be placed contemporaneously with it, this might be included in the process of our creation.†

"The *primitive fluidity* of the planets is clearly indicated by the compression of their figure, conformably to the laws of the mutual attraction of their molecules. It is also demonstrated by the regular diminution of gravity as we proceed from the equator to the poles. This state of primitive fluidity, to which we are conducted by astronomical phenomena, is also apparent from those which natural history points out." Such is the deliberate judgment of La Place.‡ Sir Isaac Newton had also, a century before, asserted the primeval fluidity of our globe. It is thus that Moses first displays it to our view, a moving, liquid, unformed mass. In this state, under the additional action of light, it began its wonderful rotation, and became the regular composition of which it now consists.

One of the grandest circumstances to which the contemplation of the heavenly bodies that form our system attaches the attention, is the surprising distances at which they are placed, and the stupendous amount of space which they occupy by their circuits. Our earth is above ninety millions of miles from the sun; Saturn is above eight hundred more miles farther off; and the next and most remote that we know, which is connected with us, the URANUS, is

* Mr. Davies Gilbert.

† The able Mr. Struve inferred that it probably received its light from the sun. It had no solid nucleus, because he saw very small stars through its nebulosity, even within a few seconds of its most brilliant point. It presented a centre of intense light nearer the border. It became more brilliant as it approached the sun, and its dimensions diminished as it came nearer to the earth. But its form in 1826 was not the same as in 1825.—Bull. Univ. 1830, p. 107.

‡ Système, vol. ii. p. 368.

twice that mighty distance.* The fact is sublime, and vast beyond the power of our words to express, or of our ideas to conceive. This last planet of our system rolls in an elliptical circle, of which 1788 millions of miles is the diameter; and therefore circumscribes an area of 5000 millions of miles. Our system occupies this amazing portion of space; and yet is but one small portion of the indescribable universe. Immense as is an area of 5000 millions of miles, yet it is but a very little section of the incomprehensible whole. Above 100,000 stars, apparently suns like ours, shine above us; and to each of these, that analogy would lead us to assign a similar appropriation of space: but of such a marvellous expansion of extent and being, although visibly real from the existence of the lucid orbs that testify its certainty to us, the mind, with all its efforts, can form no distinct idea. Thought lapses into nothingness whenever it attempts to do so; and yet, astonishing as this is, it becomes more wonderful from the fact that the distance is so immense from us before those other myriads begin, that no fixed star can be made to give a parallax by the most powerful instruments. The remoteness, therefore, of the nearest beyond the orbit of Uranus, must be what, from the poverty of earthly language, we must be content to call immeasurable.

This is indeed a marvellous mystery. It compels us to call creation an infinite immensity. It aggrandizes the CREATOR into a sublimity, that would render it the most presumptuous folly for us to imagine that he could think of or care for us, if he had not expressly revealed to us his condescending regard, and his invitation and command that we should attach ourselves to him. But this awful greatness makes that revelation the more inestimable to us; for, without such a charter, without such personal authorization

* Mr. Hornsby has made the following calculations of the absolute DISTANCE of the PLANETS from the SUN, in English miles:

Mercury	36,981,700
Venus	67,795,500
OUR EARTH	93.726,900
Mars	142,818,000
Jupiter	487,472,000
Saturn	894,162,000

Phil. Trans. 1771, vol. lxi. p. 574.

The Uranus is twice that of Saturn.

for our affectionate adoration and grateful duty, what could our reason suggest to us, while it contemplated a majesty so tremendous, but a tremulous dread and silent despair! ..... Another consideration is astounding:—When we gaze, on a clear evening, on the bright Jupiter, we are seeing an object that is 487 millions of miles from us. But when we look at the bright Orion, or the Great Bear, we are beholding substances which are myriads of times that remoteness from us. . . . The idea frequently overwhelms me, as I stand and view them, and think that I, a petty human being, have the faculty, and can exercise the power, of looking through millions of millions of miles of extended space, and that I am at that moment actually doing so—and that such an amazing expanse is pervious to my eye, and perceptible by my conscious and, in comparison, insignificant soul. But miraculousness is the true character of created nature.*

*The following Tables may be serviceable, in considering the creation of our system.

DIAMETERS of the SUN and PLANETS, in English miles.

Sun	883,246	*Juno*	1,425
Mercury	3,224	*Ceres*	163
Venus	7,687	*Pallas*	80
Our Earth	7,911	Jupiter	89,170
Moon	2,180	Saturn	79,042
Mars	4,189	Uranus	35,112
Vesta	238		

QUANTITY of MATTER, supposing that of the Earth to be 1.

Sun	339,630	Moon	0,025
Mercury	0,125	Jupiter	280,609
Venus	1,135	Saturn	103,950
Our Earth	1,000	Uranus	16,840

REVOLUTION round the Sun.

Mercury	87 days	23 hrs.	14 min.	33 sec
Venus	224	16	4	24
Our Earth	365	5	48	48
Mars	686	22	18	27
Jupiter	4,330	14	39	2
Saturn	10,746	19	16	15
Uranus	30,589	8	30	
Moon, round the Earth	27	7	43	5

Dr. Thomson's Hist. Roy. Soc. p. 358.

The last numbers would be in years:

Jupiter	11 years	10 months	15 days.
Saturn	29	5	11
Uranus	83	9	24

Thus Uranus, though but 19 times farther off the sun than we are,

In perceiving how elaborately the planets have been associated with us, and our earth with them, and all with the sun,—and have for that purpose been placed and kept apart from all the rest of the starry nations, though so numerous, —we are led to inquire what the Divine intentions were in this special connexion; and what mutual relations he has, or purposed to have, established between us. It is a natural subject of our curious thought. But he has disclosed nothing of what he has done or designs by thus linking us so particularly together. We can ascertain that we act physically on each other by our masses; but no communication of any sort has passed between us, and we are but known as a moving star to them, as they are so to us. Yet our social combination in the vast regions of space implies that some unknown relations are existing between us; and we may infer that our several destinies have some appointed reference to each other. At present, we move through the heavens in our individual solitude, as if we had no affinity together—we mutually gaze at each other, and wonder at an association so inconsequential; but it is not improbable that future ages may unfold some grand result and scenes, that will make our relationship a sublime reality.

When sufficiently arranged and consolidated, our earth was placed, with the planets, at those immensely distant points and scientifically calculated intervals, both from each other and from the sun, which would accomplish the purposes to be fulfilled in each. A mighty impulse was then added to each, apparently differing in amount, which, if it had been unchecked, would have propelled them through the endless expansion of the universe; but an attractive force was at the same time attached to the sun, which drew them, by a mysterious gravitating tendency, down to his centre. A marvellous adaptation was then skilfully and most exactly settled between these counteracting forces, and according to their individual diversities; by which,

takes 83 times the period we do for his circuit; and Saturn, though but little more than 9 times farther off, employs in his orbit 29 times that space of duration in which we accomplish our annual journey. So that different degrees of impulsive or projectile force must have been imparted to each of us: for the difference of masses does not seem to account for the diversities. Saturn is nearly 104 times our mass; while Uranus is not quite 17.

while the attraction of gravitation was made by an invariable law to be ever equal to the masses of each planet, the centrifugal or projectile impulsion, precisely proportioned in every one to that attraction, was given to each planet: so that in no one it should exceed the solar attraction, and yet that it should be always sufficient to prevent that commanding power from pulling any one out of its appointed orbit down to the absorbing centre. On this nicely-balanced adjustment of two most mighty and ever struggling and opposing forces all the movements of our planetary system are daily proceeding, ever on the verge of the most destructive danger, by either energy mastering the other; and yet such a powerful and vigilant superintendence is constantly governing both, that this perilous contest has continued nearly 6000 years without the balance varying in the slightest degree.* The most scientific harmony continues to regulate them with unabated constancy and unrelaxing exactitude—ceaseless battle with as unceasing equalization of force and energy; the most miraculous activity with the most steady maintenance of undeviating order.† Nothing but the Divine wisdom could have composed such a finely-balanced system of tremendous forces,—nothing but the Divine power could command them, or perpetuate their indispensable equality;—and nothing but the Divine will can dissolve what it is upholding.‡ We may again repeat, and

* The result of this intelligent arrangement is seen in the great laws of the planetary motions, discovered by Kepler, and illustrated by Sir Isaac Newton, among other great truths, in his immortal Principia. These briefly are—"That the planets move in ellipses round the sun—that each describes about the sun's centre equal areas in equal times—that in the orbits of different planets the squares of the periodical times are proportional to the cubes of the distances."—Hersch. p. 178.

† Of the activity of the forces that are operating in nature we may form some notion, if such extraordinary things are conceivable at all, by La Place's description of the attractive power. "*I have ascertained* that between the heavenly bodies all attractions are transmitted with a *velocity* which, if it be not infinite, SURPASSES *several thousand times* the VELOCITY of LIGHT; and we know that the light of the moon reaches the earth in less than two seconds."—Syst. vol. ii. p. 150. The annotator on La Place so amplifies this idea as to detail an algebraic demonstration, that "The gravific fluid passes over *one million* of the earth's semidiameters in a *minute* of time. Its velocity is eight millions of times greater than that of light."—Vol. ii. p. 493. Although these may be mathematical truths, yet they may be fairly classed among the incredibilia of science, however indisputable they may seem, or really be.

‡ Sir Isaac Newton's Principia and the Celestial Mechanics of La

on high human authority, that it is impossible that this can be the meaningless result of unmeaning chance; for it is La Place who has said, "One of the most remarkable phenomena of the solar system is the rigorous equality which is observed to subsist between the angular motions of rotation and revolution of each satellite. IT IS INFINITY TO UNITY that this is not the effect of hazard."*

We are therefore philosophically entitled to say, that this world, whose scientific construction appears more wonderful the more it is contemplated and understood, and the study and apprehension of whose imbodied science has enlarged and elevated the human genius to its loftiest sublimity and most enduring fame, must have been framed by a transcendent supernatural agency; and could not otherwise have become what it is;—neither could it, without the continued aid or co-operation of the same superhuman power, remain what it is—so firm, so unbroken, so undecaying, and so beautiful as we everywhere discern it to be. For it is a vast complication of multifarious parts—a very artificial arrangement of heterogeneous things, none of whose particles are in their original or natural state; and the whole and every portion—all that is in it or upon it—are in continual motion, action, reaction, and counteraction. Our reason suggests to us, that no particles put forcibly together, and continually agitated, separating and forming new combinations which never adhere together long, could

Place sufficiently show the strict geometric science, of the sublimest kind, on which all the laws and phenomena of our system have been constructed. There are several other illustrious mathematicians, whose works will furnish supplementary illustrations of the same magnificent truth.

* Syst. vol. ii. p. 366. The Marquis La Place has thus marked the five principal phenomena of the planetary system, as those which are to be considered by all who investigate the cause of its primitive movements.

I. The motions of the planets are in the same direction, and very nearly in the same plane.

II. The motions of the satellites are in the *same* direction as those of the planets.

III. The motions of rotation of these different bodies, and also of the sun, are in the same direction as their motions of projection; and in planes very little inclined to each other.

IV. The small eccentricity of the orbits of the planets and satellites.

V. The great eccentricity of the orbits of the comets; their inclinations being at the same time entirely indeterminate.—La Place, Notes to his Syst. Vol. ii. p. 354.

abide in their orderly association, and preserve their due relations, arrangements, and regularities, unless the power that made, persevered to superintend, and by its continued government compelled the discordant composition to perpetuate the order and system, and artificial subordinations and harmony, which keep the multiform diversities one combined and consisting whole. As what is complicated cannot have been eternal, nor what is full of the most abstruse science in its construction have been put together but by a highly scientific mind, so all discordant and artificial combinations, that are always in counteraction with each other, with a constant nisus to separate, could never be kept permanently together but by the unceasing application of the complicating power, and the continued superintendence of the forming intelligence. Any other supposition not only leaves an effect without a cause, but exhibits the contradiction, of an effect divested of its cause continuing to occur, in opposition to the abiding action of destroying causes and preventions operating unresistedly.

The difficulty is not lessened by the theory of a creation so perfectly formed at first, as to require no after-providence or attention; for this idea, if correctly examined, will be found to be but the assumption of an impossibility, when applied to any complicated structure. A simple atom, which, when once made to exist, cannot cease to be, and cannot alter except by His fiat who called it into being, may need no future care. But no complication of particles out of their natural state into an artificial one can continue in their forced condition without a continued action of the complicating power—and this is the creating one. The combining energy must continue to combine, or the combination in time will sever. The creating power must continue to act as the conserving power; and therefore, as a superintending Providence, preserving what it has made, supplying what wears off, supporting what declines, restoring what decays, and adding new means and impulses when new results are to be produced and new purposes accomplished. No words alone create; no words alone can be supposed to preserve. In both cases a power operates; an active power accompanies the mandate, and the necessary materials are moved by that power into the previously planned and appointed combination. The same power keeps united

what it thus unites, and what, without such compulsive agency, would never so unite, and never remain in lasting union in opposition to its original independency or difference of condition.

Hence the complicated structure and system in which all things subsist are evidence to us, that the intelligent Power which brought them together, is still abiding upon them with its original energies; and that it continues in the same action upon them which it applied in order to unite them. Thus, superintendence and continued agency appear to be essential to the subsistence of created things, in that complexity of make, in that artificial order, in which we behold them. Their component atoms can have no properties inherent in themselves to cause this cohesion; because what is originally and essentially sole and separate until it be forcibly combined cannot have any natural property or tendency to combine. Combining tendency is incompatible with original separateness. It must be the addition of some other agency. Hence nothing could remain in those beautiful but compulsory mechanisms, whose laws and principles have suggested and constitute all our science, unless the same power which created accompanied them in its providential agency; and by thus accompanying, perpetuated the duration of its sublime constructions and most interesting compositions.

The just inference from these remarks seems to be, that supernatural agency is as necessary to the present subsistence of things, as it was to produce their original formation; and that it therefore is one of those abiding and essential laws of nature to which all other laws,—those material and secondary ones which we can explore and calculate,—are but its chosen associates, its appointed and subordinated instruments. The master law and these servant laws are ever operating together in their distinct lines of action, and neither at any time without the other. Nature is never deserted by its Maker. It was not framed as an infantile toy, to be put together for a momentary amusement and then forsaken. It was made for the benefit of its inhabitants. It will never last longer than it is a subject of its Ruler's care. It will cease when his attention to it ceases, but will endure until that be withdrawn. Its continued existence is therefore a demonstration of his continuing regard and persevering care.

Instead, then, of following the fashion of some, to consider supernatural agency as an unnecessary or as an obsolete idea, accustom your mind to regard it as the primal law of nature—the ever-dominating law—the companion of every other—the grand agent which gives energy to every other—the superintending sovereignty which never abandons its creation, but which is always ready and resolved to interpose its assisting operations, whenever the additional interference becomes needful. This is the true philosophy of nature; and without a due recollection of this, great errors of reasoning, and much imperfection and incompleteness of mind, cannot but take place. All truths have a greater or less connexion with each other; and absence of the grander ones in our intellectual treasury will produce a great chasm, and much confusion and incongruities, in whatever may remain.

Avoid, therefore, all absurd prejudices theoretically against miracles. They are inseparable from existence. Creation was a miracle. Its subsistence is not less so. The true idea of a miracle is, that it is an act of Divine power—an event which the material laws of nature, without the greater law of the Divine agency, could not effect. To describe a miracle as a violation of the laws of nature is an incorrect and an inapplicable definition; for all the laws of nature are in continual violation and counteraction by each other. Fire burns, but water extinguishes it. Water is fluid, but cold converts it into a solid, and heat into air. It is the established course of nature, that all its laws should be thus violating each other. It is by such a violation that we roll yearly round the sun. This is the result of the attractive law continually violating the law of that propulsive force which every planet has received. These two laws are in a constant struggle, each violating the other; neither prevailing,—and therefore the result of their unceasing conflict and counteraction is that forced compromise, ever resisted by each, but maintained by their very resistance, which appears in our circuitous orbit. We now go round the sun by no willing movement; instead of flying off from it, as one law urges us to do, and instead of falling into it, to which the other is always drawing us—this mutual violation of each other's law compels our planet into that elliptical circuit, which is the artificial product of this appointed contest.

A miracle is therefore the exerted will and agency of that Deity, who is an unexcludable part of all nature, as well as his works: who is ever superintending them: and who acts by his natural laws in the usual course of things, and by the special operation of a miracle whenever he deems it proper to do so. He alone is the judge of the necessity or expediency of such an interference; but whatever he chooses to do for the benefit of his creatures, there is nothing to prevent him from accomplishing. He has no controller nor superior; nor does he take counsel from us as to the time, the manner, or the fitness of his interposition. Miracles are therefore at no time impossible; but, on the contrary, from the constant presence of the efficient cause, are always probable. The usual course of things is manifestly left to the operation of the mechanized and subordinated laws, as far as their visible causes appear. The supernatural interposition is not necessary, while the common events of nature only are to take place, and can occur. But when the manifestation of the Superior Power, or the production of effects to which the common laws of things are inadequate, become expedient, then what is specially needed specially ensues. The Divine agency immediately acts, and produces visible effects beyond the power of natural causes to occasion; and thus evidences its own operation. That it would not thus interfere without an adequate reason is the deduction of our judgment, which Horace has so forcibly expressed; but that it will always thus interfere whenever a sufficient occasion makes its agency expedient, our same judgment will as correctly infer; because intelligence will always act like itself, and therefore intelligently, and therefore at every period do what it is proper and right that it should do. How it has acted in this respect before our present day history only can inform us from human sources of knowledge. Authentic history declares that it has thus interposed, but on rare, and always on great occasions, and from sufficient reasons; and thus the special interference of Divine agency in the occurrence of miracles on great occasions and from sufficient reasons, is the suggestion of our past experience, and is the true philosophical probability.

I throw out these ideas for your consideration, because

sacred history, being the history of the Divine agency in human affairs, cannot but comprise the appearance, and be expected to exhibit the occurrence, of such miracles as were necessary to effectuate its objects.

LETTER III.

Creation of Vegetation—Necessity of Light and Air to it—On the Divine Agency in Nature—On the Distinction between Light and the Solar Ray.

My dear Son,

I closed my last letter with observations on that Divine superintendence and agency which accompany the continued subsistence of our natural world, because no other supposition will explain those grand phenomena which no discernible laws of nature can account for; and because wherever these act, they only operate as they do by the energy and qualities derived from the Creating Sovereign, and by the arrangement and co-operating and counteracting positions in which he has placed—and, having placed, continues to maintain them. The permanent existence of things as they are is as great a miracle as their original formation. It is their artificial, and not their natural, state; and a continued Divine agency is as strictly necessary to keep them in it, as it was to compel them at first to assume it. The Divine agency is therefore as much a principle or law of subsisting nature, as any of its secondary or material ones. It is ever actively operating, for the welfare of what it has caused to exist and perseveres to uphold—and therefore for the benefit of us, who are no inconsiderable portion of the great whole. Being thus the manifested rule and guide of our terrestrial fabric, and of its celestial companions, our reason will conduct us to the inference, that it will not be less mindful of the intelligent creatures which it has made—but that a moral providence as to them, and a moral government over them, and moral instruction to them, will be also laws and principles of its operations upon subsisting nature, as surely as those of the projectile and gravitating forces on our consolidated mass.

It is upon this foundation that all sacred history is built; and it is obviously the principal object of the first chapter of Genesis to establish in the human mind, as a primitive and essential truth, which must never be separated from it, that all existent things are the creation of the common GOD of all, the only and the universal Deity. This has been done as if with the foresight that two great errors would be raised in the world, and would be set into opposition against it:—the casual origin of things, on the one hand—or their unoriginating eternity, on the other. We learn from literary history, and we see around us in life, that these notions have occurred and are struggling for prevalence; and as you will not be able to read, or to live, without meeting with them, I again press upon your recollection, in addition to the express testimony of the Mosaic revelation in this its important and commencing section, the reasoned truths with which these mental hallucinations will be found to be incompatible.

No words can more emphatically subvert the groundless conception of the casual origin of things than the declaration of LA PLACE, who had no motive or disposition to favour any better theory, than the force and impression on his mind of the visible truth, that it is INFINITY TO UNITY against such a supposition. Less than this a mind with his knowledge of the science so essentially incorporated with nature, and so discernible in it, could not have rationally said; and it is to the credit both of his understanding and of his candour, that what he felt so strongly he has avowed so manly.

Intelligence must lose the power of discerning intelligence, or the scientific mind will feel that all Lucretian theories, of the particles of things moving themselves casually into the system we admire and are part of, are inconsistent with its visible nature and laws, and totally incompetent to account for them. But our enlightened reason, which makes this deduction, will as clearly feel, as to the other hypothesis, that the complicated structure of the world we inhabit, and of its planetary system, cannot have been eternal; because no compound, no complexity, no combination of independent and separate particles, can have been eternally in this state. An eternal compound is a natural impossibility. It is a contradiction in its terms,

and it cannot be put into any form of phrase without being so. All compounds must be unions of what were once not together; and therefore it is an absurdity to predicate eternity of them. The composing particles may, or may not, have been eternal; that is a question of fact; but never the composition. The separate letters of the alphabet may or may not have eternally subsisted, but never one single word, never any sentence; never, à fortiori, either Homer's Iliad or Newton's Principia. Never, therefore, our earth and its finely gravitating and geometrized system.

In no part of our terrestrial abode is a creating mind more visible than in its VEGETABLE kingdom; for, here, we see everywhere specific combinations producing specific effects, and no other, and with undeviating constancy and with the exactest certainty, each phenomenon arising from a peculiar and adapted organization distinct from every other, which invariably produces its suited result, and only that; yet each but the union, in different arrangements and quantities, of the same common particles. No fancied tendency will explain this. The same particles could not tend to be a thousand dissimilar things. No assumed tendency can explain diversity: a tendency to diversity is an impossibility, because that would be a tendency to be and yet not to be, which may be justly deemed an absurdity. If the particles of vegetable nature tended to form a rose, the same particles could have no tendency in themselves to compose a lily. All tendency, if such a thing existed, must be specific and uniform; it could not be variable. A tendency to form, is a tendency to do so, but cannot be also a tendency not to do so. A tendency to form a rose could never form a lily, because that would be a tendency to form and not form a rose, which would be both a self-contradiction and an impossibility. No presumed tendency can therefore explain the numerous diversities of vegetable organization. All plants are formed of similar component particles, varying only in arrangement and amount; and no particles that tended to form one composition could tend to form any other. But instead of vegetable nature being only one composition, there are from 40,000 to 80,000 diversified species.* The theory of

* "The botanist is conversant with from 80,000 to 100,000 species of plants."—Hersch. Disc. 126. This is a much larger number than former

tendencies is a mere fallacy of words. Not a single tendency has been proved to exist. All nature is, in each of its departments, an assemblance of varied compounds of similar elementary particles. A tendency of these to form any one would form only that one, and no other. But instead of all things being only multiples of a single composition, the universal character of nature is, in all its classes, that of multiform multiplicity; of compound diversity so inexhaustible, that of the inexpressible millions of millions of substances which are around us, scarcely any one is the exact counterpart of another.

You will therefore only smile when you find that some men can gravely say, and others gravely repeat, that one particle tended to unite with another, and these with others, but only in a straight line, and then, that they tended to bend that line into a ring, and then to enlarge that into a vessel, and then to branch out into other vessels, and then to make bone, and then to make blood, and then to form nerves and flesh, and then to extend into limbs, and then to make a heart, and then a pair of lungs, and then all the other functions of the human body, one after another: giving thus a thousand different and inconsistent tendencies to the same elementary particles, none of which can be proved, or is likely, to have had any tendency at all.

The true deduction of an enlightened reason therefore is, that all visible nature has originated from an intelligent Creator—that such a Creator will continue to superintend what he has made, to preserve it in existence as long as he means it to subsist—and that he who has made, and thus superintends, will be also the moral governor of his intellectual creation, and will exercise such a moral providence over them as his purposes and their welfare shall require; and will therefore make to them such communications of his sovereignty, of his mind, and of his will, as He may from time to time deem expedient.

In expressing to you these thoughts, I am only stating the process and progress of my younger mind, when it was forming its settled principles on these great subjects. I could not live contented with ignorance, nor with error. I

estimations. The laborious and active-minded Loudon mentions only 44,000, of which 38,000 had been described.—Encyc. Gard. 250.

wanted knowledge, and as I was acquiring it, I felt, what a man of misdirected talent at that time justly said, "The mind cannot unknow." All knowledge attained, makes more knowledge necessary. There is a knowledge which creates doubts that nothing but a larger knowledge can satisfy; and he who stops in the difficulty will be perplexed and uncomfortable for life.

On the vital points, of the Deity and his will, I desired certainty above all things, as far as it could be gained. Truth only on this is valuable, and it is most important to our well-being not to be without it. I sought anxiously for it, and it came to me, according to my most cautiously-exerted judgment, in the ideas which I have just expressed.

From the perception that our earth and the universe were vast compounds, and that no compound could be eternal, I proceeded to study botany, zoology, anatomy, and chymistry, that I might distinctly know what organized beings were, and in what they differed from inorganic things. I made various experiments in each; and planted seeds and watched their germinations, and dissected and examined every vegetable in my reach, to learn its structure and to observe the mode of its development and the causes of its functional products. I devoted two years specially to these considerations, when the full enjoyment of the strength and spirits of eight-and-twenty made every employment easy and pleasant, that I might have such ocular demonstrations of the course and processes of nature as I could then attain.* The result of all these inquiries was, that my mind became fully satisfied that every substance in nature was a composition of elementary particles; that no particles could of themselves form the diversified and skilful and constant organizations which were everywhere around me, and of which my own body was to myself a conscious

*I cannot but remember with thankfulness the benefit I derived, in 1795 and 1796, from the lectures of Dr. G. Pearson on Chymistry, Sir James E. Smith on Botany, and afterward on Zoology, Sir Anthony Carlisle on Comparative Anatomy, Dr. Babington on Mineralogy, and Dr. Adam Marshall on Human Anatomy. The latter, a man of strong mind, had deeply studied the mathematical construction and laws of our bony fabric, and was never happier than when explaining them. In the course which I attended, he was particularly scientific and eloquent on this subject. I remember his devoting a whole lecture to display the profound science that was visible in the formation of the double hinge of one of our joints.

specimen. Succeeding years of reflection and more knowledge have confirmed these earlier deductions, and provided a source of unceasing happiness to my enfeebled age, from the considerations to which they lead, and from the hopes and prospects which they are ever opening before it. Organization, then, became to me the decisive teacher of a creative intelligence. The elementary particles of things must have been in a separate state, before they were combined into organizations; and nothing but a designing intelligence could have formed them into these. Here my mind found its intellectual rest, of which it has never since been dispossessed.

The CREATION of VEGETABLES is placed by Moses subsequent to the production of light and of the atmosphere; immediately after the waters had receded from the land, and just before the creation and arrangement of the solar system.

This position of vegetables in the series of creation exactly answers the demands of our present knowledge. Instead of requiring the sun's light to germinate, seeds and plants, in order to do so, must be sowed and placed in darkness before they begin to vegetate.* A small heat and moisture first cause their living principle to begin its operations, but they cannot flower and fruit until they receive the solar beams; nor could they grow without light, air, and moisture.† A portion of oxygen air is essential to

* Solar light is unfriendly to first germination. Loudon mentions, as one of the "necessary conditions of germination, that the seed sown *must be defended* from the action of the rays of light."—Encycl. Gard. 194. Hence the farmer or gardener harrows or rakes in his grains.—*Ib.*

† M. Leuchs has tried many experiments of the effects of light on plants. His conclusions are, "Solar light favours in them the assimilation of carbonic acid gas—facilitates their verdure, and the formation of their volatile and aromatic principles.—It is essential to florification and fructification. We cannot obtain ripe seeds from plants reared in darkness.—Many become more lax and watery as the light is lessened—lamp or torch-light but imperfectly supplies that of the sun—they incline to it, and those near it harden to dryness; but it keeps those green, which in total darkness would become pale."—Bull. Univ. 1829, p. 54.

M. Martius observed the milky juice of the euphorbia phosphoresce to be luminous. Mr. Prinsep found that light exerts a great influence in the change of colour in plants in autumn. Its privation prevented any alteration, though in light the leaf passed from green to yellow, and sometimes to red.—*Ib.* p. 436.

Treviranus distinguishes the light and heat developed from plants, in-

vegetation.* Hence the previous atmosphere, which contains in it more than that portion, was indispensable, as was also some water on the soil where they were to grow.† This exact placing of the vegetable formation and first germination is another test of the authenticity of the Hebrew cosmogony, which random fiction could not have stood.

I was considerably affected in my younger days by the long-standing objection, that Moses made light to exist before the creation of the sun, as books then usually taught, what some still fancy, that there could not have been light without this luminary. But not choosing, on such an important point, to attach my faith to any general assertion, I sought to find out if any investigator of the nature of light had perceived any distinction in its qualities or operation, which made it a fluid, or matter, independent of the sun. It was not easy, before the year 1790, to meet with the works of any student of nature on such a subject, as it had been little attended to: but I at length saw the fact asserted by Henckel, a German of the old school, of some value in his day; and soon afterward some experiments were announced in England, which confirmed the supposition. It has been a favourite point of attention with me ever since;

dependentiy of their life, from the light and heat which are intimately connected with their existence and increase with their vigorous health. He doubts if those flowers are really luminous which have been marked as such, and concludes, from his experiments, that neither heat nor light are given out *during the life* of vegetables.—Bull. Univ. 1830, p. 257. In this conclusion I cannot concur, for I have at times remarked, after sunset, a perceptible glow in the colours of flowers, unusual to them in their common state, as if coloured light of their own colour was issuing from them. I have seen the difference in the sweet-williams, geraniums, marigolds, heart's-ease, and pinks, at various parts of the day, when the sun was not visible. It has been most apparent to me in the red flowers; next, in the yellow. It resembled an actual secretion of light, additional to their usual show. The presence of the sun upon them lessens the effect. It is most perceptible in his absence. I have noticed the same occasional appearance on the bricks in a country path. In some states of the atmosphere, when the sun was clouded, they have had a peculiar glow, without any visible causes.

* The most favourable proportion is thought to be one-fourth of oxygen, or that of the common air. Pure oxygen gas accelerates vegetation, but makes the plant feeble. In less than one-eighth of oxygen germination will not take place.

† There is a remarkable connexion between water and plants. Madden observed, in the deserts he traversed, that, "wherever there is water, no matter in what part of the wilderness, *there* vegetables are found."—Trav. in Turkey.

and no truth in philosophy seems to be now more clearly ascertained, than that light has a distinct existence, seperate and independent of the sun. This is a striking confirmation of the Mosaic record; for that expressly distinguishes the existence and operation of light from the solar action upon it, and from that radiation of it which is connected with his beams and presence. By Moses, an interval of three days is placed between the luminous creation, and the appearance and position of the sun and moon. Light was therefore operating, by its own laws and agencies, without the sun, and independently of his peculiar agency, from the first day to the fourth of our terrestrial fabrication. But from the time that the sun was placed in his central position, and his rays were appointed to act on our earth, they have been always performing most beneficial operations, essential to the general course of things.* They have also been ascertained, by Dr. Herschel, to have a power of heating, distinct from their production of light and colour,—an interesting discovery, connected with more consequences and inferences than have yet been noticed.†

The glory of Sir Isaac Newton began by his discovering that light was not simple and homogeneous; but that it consisted of seven rays of different colours and of different and invariable degrees of refrangibility. The same degree of this belonged always to the same colour, and the same colour to the same degree of refrangibility.‡ Red, yellow, and blue are the primary colours; white light their compound.

An opposing theory to this has been gradually growing up from the time of Des Cartes, and is now maintained by several men of no small name and powers in science,§ which con-

* "The rays of solar light possess several remarkable physical properties: they heat; they illuminate; they promote chymical combination; they effect chymical decompositions; they impart magnetism to steel; they alter the colours of bodies; they communicate to plants and flowers their peculiar colours; and are, in many cases, necessary to the development of their characteristic qualities."—Brewster's Life of Newton, p. 90.

† From his experiments, Dr. Herschel "drew the important conclusion, that there were *invisible* rays in the light of the sun, which had the power *of producing heat*; and which had a less degree of refrangibility than red light." These results were confirmed by Sir Henry Englefield —Dr. Brewster's Optics, p. 89.

‡ Brewster's Newton, p. 43.

§ Dr. Hooke, and Huygens, in Newton's lifetime, urged the undulatory theory, which Des Cartes had first suggested. Newton answered them. But Euler and others revived it. New observations induced

siders light to be an undulating vibration of an ethereal medium universally diffused, and not, as Newton thought, an emanation of particles direct from the sun.* La Place preferred the opinion that "Light is an emanation from a luminous body."† But the newer system comes nearest to the Mosaic fact, that light was a distinct production anterior to the sun; and appears to be gaining ground in philosophical minds.‡ Perhaps some harmonizing combination of both theories may reconcile all the phenomena, and best explain the true nature and operation of light. It seems most probable that light is an ethereal fluid now universally diffused, and pervading all things, and not an emanation from the sun; but that this luminary has a direct and additional agency upon it, whose effects we daily see.

It may not be impertinent to suggest, that light seems, like heat, to have two states,—active and latent. The active state causes its visible phenomena, and our sensation of daylight. When this subsides, by the sun's departure, into its latent state, our sense of darkness, or night, is produced. The solar rays, again emerging on it, have the power of changing its latent state into its active visibility.§ Light has also the property of being absorbed by, and, I would add, of combining with, all substances;‖ with some

Dr. Young to adopt it, with very scientific illustrations. Since he wrote, Dufresnel, A. L. Cauchy, and M. Pouillet have enforced it. Dr. Ure explains its modern shape at some length in his Geology.

* Dr. Brewster thus briefly contrasts the two systems: "In the Newtonian theory, light is supposed to consist of material particles emitted by luminous bodies; and moving through space with a velocity of 192,800 miles in a second. In the undulatory theory, an exceedingly thin and elastic medium, called ether, is supposed to fill all space, and to occupy the intervals between the particles of all material bodies."—Dr. Brewster's Optics, p. 134.

† Syst. vol. ii. p. 91.

‡ "Each of these two theories of light is beset with difficulties peculiar to itself: but the theory of undulation has made great progress in modern times; and derives such powerful support from an extensive class of phenomena, that it has been received by many of our most distinguished philosophers."—Dr. Brewster's Optics, p. 135.

§ Fresnel says, on the new theory, "If the phenomena of light be considered as the vibrations of an elastic fluid, we may infer that the direction of these vibrations is perpendicular to that of the luminous ray. This is supposed on the idea that the different parts of an elastic fluid act on each other by alternate compression and dilatation."—Bull. Univ. 1830, p. 109.

‖ "One of the most curious properties of bodies is their power of absorbing light. Charcoal is the most absorptive of all. Even the most

wholly, which are then black; with others, the most numerous cases, only in part; and then, that portion of them which is not so absorbed emanates from the substance in the colour which comes from them to our eye.*

After having for many years attended to the phenomena of light, I cannot but consider it to be a universally diffused fluid. Thus far the idea would accord with the undulatory theory; but many facts lead me also to conclude that it actually enters into the composition of all or of most substances, and, like heat, becomes a latent part of them.† From these it is extricable, with more or less rapidity, without the interference of the solar ray, as in the burning of all inflammable bodies, when it passes into its active and visible state. When the two liquids of nitrous gas and oil of turpentine burst into a flame on being mixed, without the approach of any fire, I think we see a striking instance of latent and combined light passing suddenly into the free and active state. So when that brilliant blaze occurs on dipping the iron wire into oxygen gas, it seems to be the latent light combined in the gas, evolving from it instantaneously into its visible form.

The sun has nothing to do with these phenomena, nor with any of our artificial illuminations. All these may be deemed latent light emerging from its combinations into free and active visibility. Yet most of the Newtonian princi-

transparent bodies in nature, air and water, when in sufficient thickness, are capable of absorbing a great quantity of light."—*Dr. Brewster, Optics, p. 137.*

* Sir I. Newton "concluded that the colours of natural bodies are not qualities inherent in the bodies themselves, but arise from the disposition of the particles of each body to *stop* or *absorb* certain rays; and thus to reflect more copiously the rays which are not thus absorbed."—Dr. Brewster's Life of Newton, p. 46.

Bodies absorb light in different degrees, in this order:—

Charcoal,	Black hornblende,	Mica,
Coal of all kinds,	Obsidian,	Water,
Metals in general,	Rock crystal,	Air, and
Silver,	Selenite,	Gases.
Gold,	Glass,	

Ib. Opt. 137.

†Dr. Brewster expresses the same idea, with which I have been for some time impressed: "Whatever be the difficulties which attach to the theory that supposes light to consist of material particles, we *are compelled by its properties* to admit, that light acts as if it were material; and that it enters into combinations with bodies, in order to produce the effects which we have enumerated."—Life of Newton, p. 90.

ples and laws concerning it are confirmed by the phenomena which suggested them; and so is much of the new system by those facts which have been adduced in its support.* Hence it is most probable that both theories have a foundation in truth, but require some further additions and modifications on each side to make them consistent with each other; and to remove the apparent contradictions which now keep them in the state of controversial hostility.†

There is another grand operation in the formation of material and inorganic nature, which has only become a subject of peculiar study within the last fifty or sixty years, and with which, I think, the yet unknown agencies of LIGHT

* Dr. Brewster has very ably distinguished the parts of the Newtonian doctrine of colours, which have been found strictly true, from those which later observations have disproved, and has added his own intelligent views of the new principles that have since been disclosed.—Life of Newton, chap. 7. To our more correct knowledge of light he has himself largely contributed.

† We may again notice here the surprising demands which philosophy sometimes makes on the believing principle within us, and the willing credulity with which we receive its announciations, while we erect ourselves so pugnaciously against the subjects of religious faith. Can any thing of this latter description more exceed our comprehending faculties, or more intensely press our believing ones, than what three men of great science and celebrity, Mr. Herschel, Dr. Young, and Dr. Brewster, with many similar collaborateurs, assure us to be true. I will state it in the words of the first, and add Dr. Young's illustrating calculations.

"Modern optical discoveries have disclosed, that *every point of* a medium through which a ray of light passes *is affected* with a succession of periodical *movements*, regularly recurring at equal intervals; no less than 500 *millions of millions* of times in a single second. *It is by such movements* communicated to the nerves of our eyes, *that we* see."—J. W. HERSCHEL's Discourse, p. 24.

Thus Dr. YOUNG tells us, that when we see the following colours, our eyes are affected in a second; that is, in one swing of a pendulum, or while we can pronounce one:—

In Red,	482 millions of	millions of	times;	
In Yellow,	542	ditto	ditto	ditto;
In Violet	707	ditto	ditto	ditto.

Lect. Nat. Phil. vol. ii. p. 627.

Dr. Brewster gives the numbers from Mr. Herschel with a little variation, as if after a more exact reconsideration: thus—

Red.....	477,000,000,000	Blue.....	622,000,000,000
Orange...	506,000,000,000	Indigo....	658,000,000,000
Yellow...	535,000,000,000	Violet....	699,000,000,000
Green....	577,000,000,000		

Undulations in a second.

Dr. Brewster's Optics, p. 136

Which exacts more of our faith, religion or philosophy? I think very often the latter. Why, then, more difficult in the one than in the other?

are principally concerned. This is CRYSTALLISATION.* It is that force or agency by which the constituent particles of bodies are united together into certain primitive forms, which all minerals, on being properly broken, are found to exhibit, and which become the rule and basis for the formation of the mass.† Similar figures are made on the primitive one; and of all these accumulated crystals the substance is composed, and into these it can always, by careful labour, be divided.‡ They have been traced to four fundamental forms;§ and these have been thought to be reducible to one constant and primitive original.‖ We cannot at present say that all bodies are thus crystallized, as some appear without such a state, or with such an imperfect crystallization as to make the agency questionable as to them.¶ Yet this principle seems to be a universal law in the composition of material things.** Like the rest of nature, its formation is perfectly scientific,†† and light seems to be one

* "The genius of HAUY discovered the general fact that minerals could be cloven or split in such directions as to lay bare their peculiar primitive, or fundamental forms."—Herschel's Disc. p. 79.

† "They are layers of cubic stones laid horizontally one on the other, decreasing regularly in size from the bottom to the top."—*Ib.* 240.

‡ Mr. Daniel, in his late lectures, showed that these bodies cannot be broken in any way we please, but only in certain particular directions. All the regular solid figures may be made up by piling together pieces of a regular figure, though not one resembling their compound form.—Athenæum, 23d Ap. 1831.

§ Germar admits only four fundamental systems, which he names the tesseral, pyramidal, prismatic, and hexagonal: but each of these he divides into two series,—the homoedric and the hemiedric crystals.—Bull. *Un.* 1830, p. 211. We may see a formation of this sort on melting zinc. A crystalline substance runs from it, which is perfectly crystallized in hexagonal prisms, terminated by pyramids with six faces. These crystals are produced by nature itself—are transparent—of an amber colour, and nearly as hard as steel.—*Ib.* p. 125.

‖ "The division of bodies into crystallized and uncrystallized, or imperfectly crystallized, is one of most universal importance. Almost all the phenomena produced by those natural causes which act within small limits on the immediate mechanism of solid substances are remarkably modified by their crystalline structure."—Hersch. p. 243.

Dr. Wollaston believed that the atoms of crystals were spherical, or at least spheroidal.

¶ *Ib.* p. 125.

** "Every chymical compound susceptible of assuming the solid state assumes with it a determinate crystalline form."—Hersch. p. 293.

†† "The crystalline form is in the highest degree geometrical."—Hersch p. 291.

of the great secondary agents that is used by the Great Mechanist of the universe to produce it.*

Let us now direct our attention more exclusively to the principles, and nature, and chief phenomena of the vegetable creation.

Of all vegetables, and especially in their flowers, light seems to be a component part, and the cause of all their lovely colours, and to be essential to their health and vigour.† But mere light of one simple and similar kind would not have had this effect. Its beauties arise from its consisting of seven distinct and separable rays, each varying in its refrangibility, and differently reflected.‡

Hitherto, only inorganic, brute, and unliving matter, and aerial and ethereal fluids of the same character had been made: their elementary particles had been combined together by the subordinate operation of those means or laws

* That light is concerned in crystallization has been suggested by several philosophers. Mr. Herschel has recently intimated his opinion, and one of no small weight, that "thus relations are discovered between the optical properties of bodies and their crystalline forms."—Disc. p. 263. I cannot but think that if light be studied on the Mosaic principle, that it preceded the particular formation of things, and was therefore an active agent assisting to produce them, and most probably a component part of all, many new and curious discoveries will reward the diligent and well-reasoning observer. Several phenomena which correspond with this idea have produced this persuasion; but I have not had leisure to pursue it in the researches which it requires for its scientific verification.

† "If we expose plants cholées to the sun for four or five hours, they become coloured with a green as intense as that of plants raised in the sun. Plants raised in air grow pale and fade in two or three days, if taken to a dark place. Those reared in shade, and afterward exposed for some time to the sun, will not survive another privation of light."—Leuch, Bull. Univ. 1829, p. 54. He thinks that without the light of the moon and stars, night would be fatal to vegetation. This seems too strong an inference, unless it be supposed of continued night.

‡ Dr. Brewster has very happily expressed this fact: "If the objects of the material world had been illuminated with white light, all the particles of which possessed the same degree of refrangibility, and were equally acted upon by the bodies on which they fall, *all nature would have shone with a leaden hue;* and all the combinations of external objects, and all the features of the human countenance, would have exhibited no other variety than that which they possess in a pencil sketch or a china-ink drawing. But He who has exhibited such matchless skill in the organization of material bodies, and such exquisite taste in the forms upon which they are modelled, has superadded that ethereal beauty which enhances their more permanent qualities, and presents them to us in the ever-varying colours of the spectrum."—Life of Sir I. Newton, p. 78.

to which we give the names of cohesion, attraction, gravitation, crystallization, and such like; but all these made only lifeless substances and compelled movement, without any spontaneous power or self-acting principle within them. Every thing was inert until impelled; and all motion was the effect of external force, ceasing when that ceased, and never proceeding beyond its compulsory impulse, either in direction or degree.

The Deity now proceeded to a new order and principle of creation—that which is associated more immediately to himself. This was, to arrange some of the material elements of nature into definite and interesting forms, with a curious internal mechanism, within which a living principle was to abide, spontaneously acting and producing those peculiar and impressive phenomena which only life can perform. It is this living principle which brings all that possess it into a far nearer relation to their Maker than inert and inorganic matter—for in its lowest form and activity it is still totally unlike all that is without it, and has a certain degree of assimilation to its Creator, whose essential quality is eternal, unoriginating, and ever-during life. All vitality appears to be some communication of this grand characteristic in himself to those things which possess it, and by which they become living beings. Their forms are his special invention and construction—and their principle of life is also his special and communicated gift.

The CREATION of VEGETABLES was the formation of living organized beings, with spontaneous internal powers, but without those of locomotivity; without thinking mind, and without any sensitivity discernible by us, and yet endowed with a principle of life that has many striking analogies with that which all animals possess, and which we ourselves enjoy.

Plants are distinguished for their multiplicity and variety, for that exuberance of imagination and taste which they display, and for that sense of elegance and beauty which their Maker must have had, to have so formed and diversified them. They are entirely the creation of his choice—the inventions of his rich and beautiful fancy. Their attractive shapes and qualities, and the abundant gratifications and important uses which we and our fellow-animals derive from them, explicitly show that kindness as well as

goodness actuated his mind when he projected and made them. They have been all individually designed: and special thought must have been employed in each; both in fixing their specific differences of form and products, and in perceiving what particular combinations and variations of arrangement would effect in every one its appointed end and use.

The vegetable kingdom expands everywhere before us an immense portraiture of the Divine Mind, in its contriving skill, profuse imagination, conceiving genius, and exquisite taste; as well as its interesting qualities of the most gracious benignity and the most benevolent munificence. The various flowers we behold awaken these sentiments within us, and compel our reason to make these perceptions and this inference. They are the annual heralds and ever-returning pledges to us of his continuing beneficence, of his desire to please and to benefit us, and therefore of his parental and intellectual amiabilities. They come to us, together with the attendant seasons that nurse and evolve them, as the appointed assurances that the world we inhabit is yet to be preserved, and the present course of things to go on.* The thunder, the pestilence, and the tempest awe and humble us into dismaying recollections of his tremendous omnipotence and possible visitations, and of our total inability to resist or avert them; but the beauty and benefactions of his vegetable creations—the flowers and the fruits more especially—remind and assure us of his unforgetting care, of his condescending sympathy, of his paternal attentions, and of the same affectionate benignity still actuating his mind, which must have influenced it to design and execute such lovely and benevolent productions, that display the minutest thought, most elaborate compositions, and so much personal kindness.†

* The recorded promise is, that "WHILE the earth remaineth, seed-time and harvest, and cold and heat, and summer and winter, and day and night, *shall not* cease"—Gen. ch. viii. ver. 22. . . . . This declaration has been since steadily fulfilled for nearly forty-two centuries.

† When, at night, in a dark room, we strike a light, and have the candle burning with its blaze till morning, we have a familiar instance of light without the sun; and which is independent of it. A more curious example of light in which the sun has no concern appears in the fungus rhizomorpha. "This genus, which vegetates *in dark mines*, far from the light of day, is remarkable for its phosphorescent properties. In

LETTER IV.

Outlines of some of the chief Principles and Properties of the Organization and System of the Vegetable Creation.

THE command for the rise of the VEGETABLE kingdom presents them to us in the three natural divisions of—the GRASSES, the HERBS, and the TREES: and it extended to ordain their appearing with their reproductive powers for the formation of their seeds and fruits, in order to provide for their perpetuation on earth in an unfailing succession, without any new creation.* The Deity chose that his own agency, and the secondary forces it would employ, should take the form of that organical productivity which is still as great a mystery as it has ever been—which no natural properties or powers perceptible in external nature can at all explain—and which can therefore be justly referred only to his superintending and actuating Power, that prefers to act in this unseen efficacy, rather than in the perpetual display of manifest new creations. The invisible miracle is left to be inferred by the human sagacity, from the wonderful phenomena that are continually occurring to our eyesight, which no human or known natural agency can account for. It is thus that he makes his eternal Power and Godhead the deduction of our reason and the sentiment of our intellectual sensibility, as well as a communicated truth from his personal revelation. The appeal has been felt by all nations in all ages, although few have acted properly or consistently with the sublime impression.

Let us review some of the main features that were se-

the coal mines near Dresden, it gives those places the air of an enchanted castle. The roofs, walls, and pillars are entirely covered with them; *their beautiful light almost dazzling the eye.*"—Ed. Phil. Journ 14, p. 178.

M. Marcel de Serres justly says, "Volcanoes which emit torrents of light teach us—que la lumiere est entrée dans la composition du globe—and not from the sun."—Geognosie Int. xix. Paris, 1829.

* "And ELOHIM said, Let the earth bring forth grass, the herb yielding seed, and the fruit-tree yielding fruit after his kind, whose seed is in itself, upon the earth: and it was so."—Gen. ch. i. ver. 11.

lected and adopted to mark and constitute the system for that peculiar order of living things which the vegetable tribes display.

All vegetables, in every region, and of all sorts, from the most minute to the most towering,—and they are of every degree and variety of size, from that pettiness which escapes our natural sight, to that magnitude which we feel to be gigantic and would deem sublime, but that greater things are about us,—have these properties in common with all animals and with the human race—organization; an interior power of progressive growth; a principle of life, with many phenomena that resemble irritability, excitability, and susceptibility; and a self-reproductive and multiplying faculty. In all these qualities they are distinguished from inorganic and earthy matter, and from all fluids and gases; and by these are raised high in the scale of being above them. In these they resemble all animated nature, and our prouder selves. We may dislike such a relationship; but to this extent our bodily frame and functions establish a natural kinship between us. They are very humble cousins, but we cannot destroy the organical and living affinity, nor escape the closing assimilation. We decline and die, as they do; and they sicken, fade, die, and decay, like every human being. There is also another analogy. Their substance nourishes us, and ours not unfrequently becomes a part of theirs. They can feed on us, as we more continually and universally do on them. All living nature is linked together by actual connexion, if not by perceivable sympathies.

Organization of Plants.—An organized being is a peculiar conception and fabrication of the Divine mind. And vegetables have been caused to be organized beings of definite figures, diversified from each other into distinct classes and species; but each species constantly retaining and perpetuating its own peculiar configurations and the qualities thence resulting—and all with a living principle within them. Life and organization are inseparable companions.

To form a correct idea of what an organized being is, you may observe, that in human mechanism we have an imitation and an analogy of vegetable and animal organization, which enable us more fully to understand it, and to perceive how it has originated. Neither watches, cotton-mills, nor steam-engines grow: they must be made by hu-

man hands, under the direction of a designing thought and will; and this mode of their fabrication discovers to us how all similar things whose forming agents we have not seen at work, and therefore how all natural organizations whose principles of construction are the same, and of which they are in perfect similitude, must have been made.

All mechanism, from the pair of tongs or the snuffers, to the windmill, the ship, and the manufacturing machines, consist of pieces or particles of matter taken out of their natural and preceding state, and put into a peculiar arrangement in due relation to each other, so that, from this specific combination, the action of the completed thing may produce the effect intended by its planning, adjusting, and commanding maker. Such are the mechanisms of man, and such are the organizations or mechanisms of his Creator. The plant, and the animal, and the human being are, in their bodily structure, material machines. They are so many mechanized substances, consisting of parts that have been put together from some other state into designed and adapted arrangements; and, by their artificial and special construction, they each possess and exert powers which thence arise, and produce the phenomena which it was intended to effect. Nothing but human workmanship and skill will account for human mechanism. No metal in the mine could by any chance move itself into the wheels, and springs, and parts, and adjustment which constitute a watch or an organ, and begin marking time or playing a melody. So nothing but Divine agency and intelligence will explain the manner in which the inert particles of things became combined originally into vegetable or animal organizations; because all other known agencies are known to be utterly incompetent to such effects. In neither human nor Divine mechanisms do the parts of which they consist tend in themselves to be what they are, or to do what they do. Iron has no tendency to be a hammer or a chain; nor brass to be in a clock or cannon, or in a telescope, or in a piano-forte. So none of the particles that constitute plants have any natural tendency to be a carnation, an apple or an acorn, nor to form animal flesh, or to be wings, feathers, feet, or fins.

In all cases of mechanism and organizations, the forming parts and particles have been taken out of their natural and preceding state, and have been put into those mechanized

positions and combinations by some thinking, willing, and competent agent, for the express purpose of their being thereby made to be the artificial figure and individual things which we see them respectively to be, and of doing the precise and determinate actions and effects which each of them separately and peculiarly perform. Such are organizations in general: and plants are that peculiar species of their construction which display to us the Divine ideas in this class of natural being; and which form the largest compartment in the immense panorama of the surface of our terrestrial fabric.

Without affirming a plant to be a real animal, as some of the Grecian philosophers imagined,* we shall best understand its true nature and construction, by considering it as an animal in the principle of its systematic form; but without being sentient or intelligent; and differing also in one essential point in the matter of its composition.† They are distinguished also by another general peculiarity in their material nature. Animal bodies seem, by some interior though yet unknown process, to produce lime‡—plants, never; but these, as their appropriate function, appear to generate carbon instead.§ The absence of any intellectual quality

* Plutarch remarks, that Plato, Anaxagoras, and Democritus thought vegetables to be earthly animals. So did Empedocles. But Aristotle, while he granted to them life like animals, denied their being such, because these have appetite, sense, and reason, in which plants are deficient.—Plut. Plac. Phil. c. 26.

† This distinction in the material substance is, that azote is an invariable part of the compound of all animals, but not of plants; while carbon is the characteristic of the latter. On burning either, the azotic smell immediately marks the animal. "The most essential of the compounds of vegetables are carbon, oxygen, and hydrogen merely. A small proportion of nitrogen, or azote, is said to be formed only in cruciform plants."—London Encyc. Gard. 193.

‡ I cannot but concur, according to our present knowledge, with Dr. Macculloch, that "the solid spoils of animals, chiefly marine, constitute *limestones* at present; and have produced them, at distant and different periods; nor, for those of the present times, is there any other origin than animal chymistry."—Maccul. Geology, vol. ii. p. 414. We see one species of this matter in daily formation now by the coral insects; and other kinds in the eggs of birds, in the bones of all animals, in the chalkstones of the human hands and feet, and in the frequent ossification of our vascular system.

§ Dr. Macculloch rightly intimates, that it is less safe to infer "that there is no other origin for carbon than vegetable chymistry."—Ib. p. 414. This is truly said, because there appears to be a carbon in the ancient rocks of the earth, which must hav preceded vegetation. But that

makes their principle of life to be very dissimilar to, or at least very distinct from, that of animals.*

Most vegetables have an upright body, with vessels ascending and communicating with each other, as in us, but with sap instead of blood; with woody fibres, instead of bone; with pith, instead of brain and nerve; with bark or rind, instead of skin or hide.† Their leaves imbibe air, as we breathe it, and also light and moisture; and in their continual motion answer the purposes of our respiration and exercise. They also imbibe and expire an aerial fluid, as we do, though with this difference, that they emit oxygen gas, under the influence of the solar rays, while animals absorb and retain it.‡ They require food, as we do, but

plants convert some of their nutritive fluids into carbon, has every evidence of being a general fact.

* Haller considered plants to possess spontaneous motion, to exhibit evident marks of irritability, and to obey the operation of stimulants, but that they had no nerves. M. Gœppert found that narcotic poison did not affect them, but a drop of prussic acid put on a flower caused an immediate motion of its stamina to the pistillum. The stamina of the common barberry contract on the touch of an insect or strange body.—Bull. Univ. 1830, p. 264. But this may be an electrical effect, which the movements of the sensitive plant seem to be. M. Poiteau says, that a seed always polarizes itself in its germination. Its radicle becoming one of its poles, and the plumula the other. Electricity may cause this. There are 34 families of plants which are voluble: they are chiefly in the torrid zone, and make one turn in 24 hours.—Bull. Univ. 1829, p. 69. But this seems to be a physical action of the light or sun, as the closing and opening of the tulip, the daisy, and the convolvulus are. M. Morren ascribes the motion of the zoocarpes to the effect of electrical disengagement *Ib.* 1830, *p.* 260.

Gardeners have an impression that the orchis latifolia *walks*, as it never keeps to the place where it is put; and Bosc admitted its walking; but M. Morren found, on examination, that it was an oscillation of two alternate bulbs, and not an actual progression.—*Ib.*

† "Linnæus thought the PITH to be the seat of life and source of vegetation. There is, in certain respects, an analogy between the medulla of plants and the nervous system of animals. It is no less assiduously protected than the spinal marrow, or principal nerve. It is branched off and diffused through the plant, as nerves are through the animal. Mr. Lindsey thought he demonstrated the medulla in the sensitive plant to be the seat of irritability. I cannot but incline to the opinion that it is a reservoir of vital energy, even in the bulbous grasses."—Sir J. Smith, Introd. 40–42.

‡ "It is agreed that, in the daytime, plants imbibe from the atmosphere carbonic acid gas; that they decompose it, absorb the carbon as matter of nourishment, which is added to the sap, and emit the oxygen. This same gas they absorb from water when it is separated from that fluid by the action of light.... In the dark, plants give out carbon and absorb oxygen."—Smith, *ib.* 212, 213.

their roots are their mouths. They have not, like quadrupeds, a particular stomach and hepatic system for its digestion; but, like some of the lower animals, they have a power of assimilating and converting what they take into their own substance, without these functions.* But all vegetables are fixed in their place of growth; they have no locomotive power. Where they are born they live and die. This circumstance would alone make them a peculiar class of beings, if they had every other similitude to animal existences. They are living beings, but with no power of spontaneous moveability from their first station of development.†

The seed contains the embryo plant in the little corculum, which all, on being carefully opened, display. It is familiarly called the heart of the walnut—the little figure at one end of all nuts and kernels. Vessels extend from this to the substance in which it lies, which has received the name of cotyledon. If this be single, as in the grasses and corn, it is a monocotyledon seed and plant;‡ if, as in the larger herbs and trees, it consists of two lobes, they are

* With respect to those minute and simply-constructed animals, the polypes and the lower tribes of worms, their feelers, put forth into the water, seem scarcely different from roots seeking their food in the earth. Some of these may be turned inside out, like a glove, without any disturbance of their ordinary functions."—Smith, *ib.* p. 3.

† The vegetables that swim and live in water unattached to any soil, and which are nourished by what they float in, do not move themselves. They only follow the impulse of the stream. Nor has the curious AIR-PLANT of China more self-motivity from not being fixed to any earth, but living in and on the air and light. It has the same want of locomotivity. This singular vegetable has been thus mentioned:—

"Epidendron, flos aeris, a plant indigenous in China; famous for the beauty of its flowers and the sweetness of its perfume. It lives only on air. The Chinese suspend it round the ceiling of their rooms. Prince Leopold obtained a branch three feet along. It had some hundreds of large scarlet and yellow flowers."—Bull. Univ. 1829, p. 167.

‡ "There is a tribe of plants, called *monocotyledons*, characterized by having only one lobe to the seed. To these belong the natural order of palms, which being the most lofty, and, in some instances, the most long-lived of plants, have justly acquired the name of trees. Yet they are rather perennial herbaceous plants, having nothing in common with the growth of trees in general. The palms are formed of successive crowns of leaves which spring directly from the root. The common orange lily and white lily belong to the same natural family of monocotyledons. Their stems, though only of annual duration, are formed nearly on the same principle as a palm; and are really congeries of leaves rising one above another, and united by their bases into an apparent stem."—Smith's Int. Bot. p. 59.

called dicotyledons ;* if no such are discernible at all, they are termed acotyledon plants,† which in some, and perhaps in most, countries are the most numerous.‡ All plants consist of two substances, vessels and cellular tissue. In general language, what is not one may be deemed the other. But for the delineation of the various parts of their mechanical structure, I would refer you to the latest publications of our scientific botanists. I shall only notice their more remarkable properties, which illustrate the principles and purposes of their Creator.

Their growth and nutrition.—The seed of plants resembles the animal ovum or egg. The embryo in both is at one end, with vessels ramifying into the rest of the substance, and deriving from that its first nutriment. The access of a certain degree of heat is necessary to begin the activity and development in both; and when that occurs to the seed, in a proper soil and place, and with sufficient moisture, vegetation begins. The cotyledons swell and rise in the seminal leaves. The corculum lengthens downwards in the germ of the radicle, and its upper part ascends in the plumula. A nutritious matter passes from the seminal leaves to the radicle, which daily elongates.◊ The process of vegetation, thus beginning from the cotyledons, steadily proceeds under its subsequent nourishment from the earth and air, until the perfect plant is formed.‖

* M. Desfontaines has made an important discrimination: "Plants in which the bark, wood, and pith, are distinct, spring from seeds with two lobes, or dicotyledons. Those where these are blended, form the monocotyledons."

† "Some think that all *acotyledon* plants, as mushrooms, mosses, &c. are entirely composed of cellular tissue, without vessels; and that monocotyledons have the *cellular* and *vascular* systems blended together through the entire stem; while all the dicotyledons have the two systems so *symmetrically arranged*, that the bark, wood, and pith are always distinguishable from each other."—Edinb. Rev. No. 99, p. 154.

‡ Thus in Denmark "The cotyledon plants amount to 1600; and the acotyledon ones to 3280."—Bull. Univ. 1830, p. 269.

◊ "We then see a white cylindrical body develop at this point, while the embryo of the plumula remains stationary. From the end of this white body the radicle issues; and soon penetrating the earth, attracts the fluids which make its lymph."—M. Feburier. Bull. Univ. 1830, p. 74.

‖ "This lymph, by mixing with the nutritive substance that descends from the seminal leaves, forms the sap, which ascends to the plumula. Thus, the seminal leaves may be deemed the upper points of the roots of the plant, with which they have a direct communication by the stalk which separates them. The radicle is fixed in a contrary sense to the leaves, be-

Nothing is more curious in nature than the persevering efforts made by the living principle in plants to force their radicle downwards; whatever efforts may be made to give it another direction are constantly baffled by the growing power, which knows where its nutrition lies, and will go rightly to seek it. No animal can display a more persisting volition.* Yet when circumstances become such, that its food is not downwards, but upwards, it will then, and then only, rest in that inverted and ascending position.† Earth is not so essential to vegetable growth as moisture; for even trees will grow in water only.‡ Earth is but the bed in which the vegetable nutriment is best prepared and presented to the absorbing roots. This is now stated to be an oxyde of carbon or humic acid, made by a chymical union with water, and which forms that humus or soil that most occasions or promotes vegetation.§ Without this vegetable

cause the bundles of fibres which produce it, and the lymph which makes its first nourishment, descend from the cotyledons."—Feburier, *ib.*

* "The young root is the first part of the infant plant that comes forth; and by an unerring law of nature it is sent downwards, to seek out nourishment, as well as to fix the plant in the ground. In whatever position seeds happen to lie in the earth, the root makes more or less of a curve, in order to shoot downwards. Mr. Hunter sowed a number of seeds in a basket of earth placed on an axis, by which their position was a little altered every day. After the basket had thus made two or three circumvolutions, the young roots were found to *have formed as many turns*, in attempting to attain their natural perpendicular direction."—Smith, Introd. p. 95.

† Dr. Walker remarks, "The ascent of the plume and the descent of the radicle is surprising. It is not merely to ascend or descend, but the endeavour of the one is to get into the air, and of the other into the earth. For, if placed to the *roof* of a cave, or in an inverted flower-pot, then, as I have often seen, the *radicle ascends* and the plume descends, the one to the earth above it the other to the air below it."—Woodh. Lord Kames, vol. ii. Ap. p. 64.

‡ "Du Hamel reared in water, plants of the horse-chestnut and almond to some considerable size, and an oak till it was eight years old; but they made less and less progress every year. Their roots were found to be in a very bad state, and they died.—Loudon, Encyc. Gard. 197..... Plants, though vegetating merely in water, do yet augment the quantity of their carbon."—*Ib.*.... Plants seem to have a mysterious power of making carbon, which may account for their growing a while in water only.

§ Dr. Sprengel expresses this principle. His ideas are, that the humic acid and humates become the nutritive principles of plants; that they are formed at first from the soft parts of plants, and afterward from the dissolution of their fibres; that in their decomposition, one part of their carbon combines with the oxygen of the air, and produces carbonic acid, which seperates itself; and also the humic acid, which combines chymi-

humus, and the humic acid which is found in it, plants will not grow, or soon decay.*

When the plant develops in the fitting soil, the roots nourish it from below, and the leaves above contribute also their auxiliary supplies.† Buds emerge in due time from the stem or branches, each of which may be considered as a new vegetable, growing from its parent, but living in unseparating union with it, yet only in close association, for it seeks its own independent nurture by its distinct though strictly combined root.‡

Plants with few and small leaves depend chiefly on the soil. Those with many and large ones more on the atmosphere.§ But some can find nutriment and grow even from animals. Thus cryptogamic plants have been found vegetating on living wasps in the West Indies.‖ This curious fact has been also noticed elsewhere.¶ They will even

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cally with water, for which it has a great capacity, and is imbibed by plants.—Bull. Univ. 1830, p. 205.

* "Heaths furnish a humus that suits few vegetables. Hence, vegetation is so uniform on their steril plains. Plants cultivated on such grounds do not increase, unless we mix marl or dung. In nature, turf is that which contains the greatest quantity of humic acid."—Dr. Sprengel, *ib.* p. 202.

† "If the air contain a certain quantity of humidity, the leaves attract a part of it; while they contribute to the elaboration of the plants peculiar fluids, which pass through the proper vessels of the bark and wood. The combination of these fluids with the sap of the leaves and that of the roots forms the cambium which penetrates between the wood and bark, and makes there the new woody substance; while the sap, descending to the extremity of the radicle, contributes to elongate, and often to make new ramifications from it."—Febur. *ib.* That the leaves nourish the bark appears from Mr. Knight's experiments: when he reduced the number of leaves in a shoot, the bark became shrivelled and dry.—Phil. Trans. 1801.

‡ M. Poiteau remarks, that "A tree or plant is not a simple individual. It is a union of universally independent plants, arising each from a bud. This bud may be considered as a seed, which produces latent roots that descend towards the earth, and constitute the fibres of the wood." He shows that the woody fibres are the roots of the buds.

§ Bernett, in Quart. Journ. Science, No. 12, p. 286.

‖ Mr. Ricord, in Guadaloupe, saw many wasps laden with these parasitical excrescences, which had taken root on their sternum.—Bull. Univ. 1829, p. 137.

¶ Dr. Madiana had thought that the plants sphæria, clavaria, and other mushrooms, which were found on the bodies of some insects, had grown there only since their death; but Dr. Mitchell ascertained,—

I. That the vegetation observed on the bodies of insects is not peculiar to one kind, but was on several, as wasps, sphynx, and May-bugs.

grow in the stomach of living animals; for several instances of this have occurred, in which the force of vegetation has prevailed over the animal's digestive power; at least, in those who were entirely carnivorous.*

Warmth and moisture usually commence the process of germination as soon as they concur to the seed; but if the due means for the further nutriment do not accompany the growth, the process stops, and the plant soon dies.† Some vegetables—the parasitic tribes—fasten on a larger plant or tree, and fixing in them their roots, derive food from its nutritive juices.‡ The living principle exerts itself with singular force and apparent judgment in searching for its nutrition when the ordinary sources and supply of it fail.§ The main fluid in vegetables is the sap. "It is really the blood of the plant, by which the whole body is nourished, and from which the peculiar secretions are made."‖

Vegetables are not generally affected by the narcotic poisons, but they will absorb arsenic by their vessels and

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II. That the bodies of insects nourish several kinds of plants, as sphæria, clavaria, and some others.

III. And that some part of these vegetable parasites begin their destructive operation on the bodies of living animals, like the larvæ of ichneumon, and continue it until their death."—Bull. Univ. 1829, p. 226.

* Thus, of three gneiss pebbles taken out of a cod's stomach, on one a plant of the fucus kind, fucus confervoides, of a deep green, was found growing in active vegetation, and nearly two feet long; on the other, a plant two-thirds shorter than the former was growing; and another was attached to it about three inches long. The stones adhered strongly to the substance of the stomach, and were cut out from it.—Quart. Journ. Scien. No. 10, p. 443.

† Smith's Introd. 99. Germination will sometimes begin without either earth or water. It was stated in the Méd. Bot. Society, that Mr. Currie had enclosed some potatoes in a zinc box hermetically sealed, and from which all stimulants had been excluded, and yet they began to shoot freely there.

‡ *Ib.* 102.

§ Dr. Walker mentioned to Sir J. Smith, that an ash-tree which grew from a seed on a wall stopped its growth for a while, having exhausted the nutriment there; but sent a root down the wall until it reached the ground, and as soon as this was established in the soil, the tree resumed its vegetation and became of large size.—Smith's Introd. Bot. p. 114. And see Trans. Linn. Soc. vol. ii. p. 268.

‖ Smith's Bot. p. 45. Dutrochet, from his experiments, concluded that there is no actual circulation of the sap, but an ascending and descending current, with a lateral diffusion of it; that it ascends through cylindrical tubes which permeate both the alburnum and old wood; that lateral diffusion of the sap and elaborated juice is carried on through the organic membrane, which forms the cellular tissue; and that the secretion in plants and their nutrition depend chiefly on electrical agency.

cellular tissues.* Iodine facilitates the germination of seeds much more than chlorine, if they be watered with a solution of it: even those which have apparently lost all vital power, may frequently be made to germinate by iodine.†

Light represses the evolution of the seed,‡ but is essential to the production of the florification and fruit; yet, as if to show us that all things are but what they are specifically organized and actuated to be, and never are the chance productions of blind necessity, there is one plant which has been so formed as to flower *only* in the dark,—the night-flowering cereus. But all such exceptions in nature are never casual, but always regularly arise from a peculiarity of structure, which is adapted to cause the particular result, and which is always constant in the species in which it occurs.§ Plants will germinate in rarefied air, but not rapidly.‖

The parts of plants have a singular homogeneity, or sameness of nature and properties. Roots may be made to produce leaves, and buds of leaves may be transformed into

* Bull. Univ. 1829, p. 56, 57. M. Leuchs found that metals, either as oxides or salts, lead, mercury, and tin, are certain poisons. Buildings, if covered with oil in which one of these salts has been dissolved, will never have cryptogamiæ. The mineral acids are also destructive.—Bull. Univ. 1830, p. 261. And see Wirgman's Experiments, *ib.* 1829, p. 374.

† *Ib.* p. 74. The vegetable acids and their salts favour the development; so do the alkalis and sulphur. Solutions of alcohol, camphor, and essential oils accelerate vegetation, especially camphor; but in their concentrated state destroy it. The aromatic infusions, sugar and gum, promote it, if they do not ferment.—Leuchs, *ib.*

‡ Some seeds that were sown and deprived of light began to germinate on the ninth day; but those which were exposed to it in a transparent glass had not germinated on the fifteenth.—Bull. Univ. 1829, p. 310.

§ This plant belongs to Jamaica and Vera Cruz; but there was an instance of it, in July, 1829, in England. It was several weeks advancing to maturity, enclosed in a husk of unpromising appearance. It was thus described, as then at Mr. Barry's, at Marbury. "About seven in the evening it begins to expand, and arrives at midnight to perfection; at seven the next morning it is closed. The circumference of the flower is twenty-four inches. A ray of small globular leaves, of the most delicate and lovely whiteness, are enclosed by others of a deep orange colour."—Macclesfield Courier.

‖ Dobreener put earth sowed with barley under two glass vessels, in one of which he condensed the air, and exhausted it from the other. Germination took place at the same time in both; but at the end of a fortnight, the shoots in the rarefied were but six inches long, and in the condensed, ten.—Bull. Univ. 1830, p. 265.

buds of flowers.* If a tree be inverted by planting it by the stalk, its roots then disclose leaves, and its branches send out roots.† Plants grow most in the night: at noon, all increase is suspended. Between morning and noon, and noon and evening, it is but small. But flowers advance more in the day, and especially in the meridian light and heat.‡ Some plants and trees will continue to vegetate, though overflooded by sea-water.§ So tenacious of its vitality and power their living principle is often found to be.

It is not merely in their principles and analogies of construction, nutrition, and growth that plants resemble animals; but the creative Hand has linked and established the affinity between them by causing some vegetables to produce animal products, and to be, as it were, the animals whose peculiar properties they imitate. Thus their living principle, in peculiar and adapted organizations, can imitate the bee, the cow, and the sheep; for the myrica pennsylvanica yields an annual supply of vegetable wax;‖ the palo de vaca, in South America, gives a copious emission of

* "In diplotanis tenuifolia was a *transformation* of the *floral* organs into real *leaves*. This accident has been observed in many other plants."—Bull. Univ. 1830, p. 257.

† Linnæus said the tree was nothing but the body of the root above ground. Hence, trees will bear inverting, and will grow as well as before, because, being only root, in whatever position the root is planted it will grow.—Smith's Lectures. Dr. Smith was more inclined to call the root a subterraneous stem.—Bot. Introd. p. 104.

‡ Ch. Mulden, Bib. Univ. 1830, p. 267. Martius considers the flowers to be composed of a union of concentric order of leaves metamorphosed. He thinks all the organs of the flower, the calyx, corolla, stamina, and fruit, are all metamorphosed leaves, different only in the degree of the changing action.—*Ib.* 268. It is perhaps more just to consider them all as products of the same materials, modified by specific actions into the different parts, rather than actual transformations. There is no mutation without a specific cause.

§ After an inundation of Friesland, in 1825, the oak, the mulberry, pear, and peach trees, and deep-rooted ones, did not suffer; nor the asparagus: the onions, celery, pumpkins, and some others, were never finer. But the vines and gooseberries contracted a salt taste, and the apricots, apples, cherries, poplars, elms, beech, and willows could not stand it. They pushed out a few leaves, and then declined.—Bull. Univ. 1829, p. 225.

‖ M. Serret mentions it as a small arbuste, which may be easily cultivated on poor soils. From a surface of 150 square feet he obtained every year from one pound and a half to two pounds of wax.—Bull. Univ. 1829, p. 172. Humboldt also mentions a palm, the trunk of which was covered with a vegetable wax, which the natives employed for their tapers.

actual milk;* and another tree, in Guayaquil, produces a fine wool;† while one in China secretes a tallow, like animal fat.‡ The tillandria, of Buenos Ayres, resembles another element, in becoming a kind of vegetable fountain, for it yields on incision a copious quantity of pure water.§ They have even some relations, yet unexplored, with the mineral kingdom; for they not only form the carbon they contain, but some have been found to have copper particles,‖ and several to secrete flint,¶ and likewise sulphur, as in our

* Humboldt found this tree in Venezuela, and Lockart met with many in Carraccas. One was 100 feet high and 7 in diameter. The milk was agreeable, and used by the inhabitants. Smith saw it on the river Demerary. It was there called Hya Hya. The milk was drinkable, and rich, and thicker than that of cows; it was not bitter, but a little viscous, and mixed with coffee it could not be distinguished from animal milk.—Bull. Univ. 1830, p. 125, 295. . . . Humboldt describes it as a handsome tree, resembling the broad-leaved star-apple. Upon making incisions in the trunk, a glutinous milk issues abundantly, of a pleasing and balmy smell. It flows most copiously at sunrise, when the natives take their bowls to the tree to milk it. It seemed peculiar to the Cordilleras of the coast.

† "Ceibo wool is the product of a very high and tufted tree. At the proper season this is covered with white blossoms, in each of which is a pod, which increases to near two inches in length and one in thickness. In this pod, when ripe, the wool is contained. It is a tuft like cotton, but softer to the touch, and of a reddish cast. Its filaments are so fine that the natives think it cannot be spun, and only use it to fill mattresses."—Ulloa's Voyage to New Spain

‡ This has been lately introduced into the Mauritius, and successfully cultivated. The tallow obtained from it is stated to be equal to that which is melted from the fat of animals.

§ It is a genus of the hexand. monog., like an aloe in general appearance, with leaves and stem like a lily, the leaves springing from the root. It yields a quantity of pure water, so good that the woodmen of the forests never take any with them. They perforate the plant near the root, and the water gushes out as clear as crystal. From the fullest plants, about two quarts may be obtained.—Andrews's Journey.

‖ "That copper exists in a great number of vegetables was announced in 1817, by Mr. Meissner. M. Tarzeau found 5 milligrams of copper in a kilogramme of gray quinquina, 8 in Martinico coffee, and nearly 5 in wheat."—Bull. Univ. 1830, p. 137.

¶ "The cuticle of grapes contains a large proportion of silex. Wheat straw may be melted into a colourless glass with the blowpipe, without any addition. Barley straw melts into a glass of a topaz-yellow colour. The bamboo secretes the tabasheer, which consists of silica with a minute quantity of lime and vegetable matter."—Lindsey's Nat. Syst. Bot. p. 309.... "The equisetum makes a natural file, and even brass cannot resist its action."—Smith's Introd. Bot. p. 76.... "The ashes of this tribe contain half their weight of silica. It is so abundant in the equis. hism. that after Mr. Siveright removed the vegetable matter it yet retained the form."—Lind. p. 311.

common corn.* We may add iron and gold also, for both of these metals have been found in vegetables, and more especially the former.† Thus all the departments of nature have been made with mutual associations; the material causes and references of which we have not yet explored.

The food of plants peculiarly distinguishes them from animals. While these subsist only on what has been organic matter, vegetables derive their nourishment from that which is inorganic, as mere earths, salts, water, or the gases. The particles of these become arranged in them, by the agency of their living principle, into organized substances, and by this mysterious process are fitted for animal nutrition.‡ The vessels of vegetables are so fine in their radicles and leaves, and in the smaller plants, that the particles which they imbibe must be in the most attenuated state. They are injured, like animals, by too great a supply of what they feed on; and hence many plants decline or perish on too rich a soil. Each will grow only on that kind of ground which suits its organs or appointed functions.§

The kindred nature of all plants is surprisingly shown by

* "Sulphur exists in combination with different bases in wheat, barley, rye, oats, maize, millet, and rice."—Lind. Nat. Bot. 303.

† "The ashes of hard and woody plants, as the oak, are said to contain nearly one-twelfth part of their own weight of oxide of iron. The oxide of manganese was first detected in the ashes of vegetables by Scheele, and afterward found by Proust in those of the vine, pine, green-oak, and fig-tree. Saussure observes, that the proportion of iron and manganese augments as the vegetation advances. The leaves furnish more of these in autumn than in spring. Gold is found only in very minute portions."—Loudon's Encyc. Gard. p. 193.

‡ M. Mirbel made this observation: "So that it should seem to be the office of vegetable life alone to transform dead matter into organized living bodies."—Mirbel's Anat. Veget. vol. i. p. 19. Sir J. L. Smith adds to it, "This idea appears to me so just, that I have in vain sought for any exception to it."—Introd. Bot. p. 6.

§ Thus while the "festuca sylvatica abounds everywhere, the F. uniglumis only where it can imbibe *marine* salt; and the F. pinnata upon *calcareous* soil alone. Many of the maiden-hairs and ferns, pellitory, &c. are attached in the crevices of old walls, as if seeking for the calcareous nitrate found there."—Journ. Naturalist, p. 25.

Thus WHEAT, so fertile and familiar to us, will not grow in Otaheite, or in any of the Polynesian islands. It has been often tried, but has always failed.—Ellis, Polyn. Res. vol. i. p. 348. *Egyptian* wheat was planted, but with the same result. It grew remarkably well, the leaf green, the stalks high and strong, and the ears large; but as they began to turn yellow, it appeared that scarcely one contained a single grain of corn, and the few found were shrivelled and dry.—Ib 444.

the power and effect of their growing and fructifying when grafted on each other—one organization attaching its vascularity to that of another, and feeding on its sap. The ancients took some pleasure in these experiments, for Plutarch saw, and notices, in a garden on the Cephissus, an olive upon a juniper, a peach upon a myrtle; pears upon an oak, apples on a plane-tree, and mulberries upon a fig.* In Holland a rose was grafted on an orange-tree;† and in our times, carnations have been ingrafted on fennel,‡ and a peach upon a mulberry.§ So an inhabitant of Lyons inserted on the same stem red and white grapes, peaches, and apricots.‖ Such facts prove the absolute similarity in nature of the different classes of the vegetable kingdom. Their general system and principle of life are the same. It is the specific and purposed variation of their organizations which, from the same material elements, causes the specific diversities of their products to appear.¶ No result is a random accident.

Plants have been manifestly designed and framed on the principle of improvability. This also highly distinguishes the latent powers of their living principle, and its vast superiority over inorganic matter. It is a truly wondrous faculty, for it is one of the greatest distinctions of man. Animals have it to a certain degree, but very limited, and

* "But," he adds, "those of an oily nature will not admit of such mixtures; for we never see a pine, a fir, or a cypress bear a graft of another kind."—Plut. Sympos. lib. 2, quest. 6. Pliny, Varro, and Columella speak of apples and vines on elms and poplars, but these grafts seem not to have had any long duration; they succeed best on the most congenial trees.

† Evelyn mentions that he saw this.

‡ The flowers will be entirely green as well as the plants. For two or three years the colour will remain the same; and after that, change to those hues which are common to the flower."—Heref. Journal, Nov. 1824.

§ The fruit will have the purple die to the stone, and the pleasant acid flavour.—*Ib.*

‖ "All flowered at the same time, and gave ripe fruit within a few days of each other."—Litt. Gaz. 15 Aug. 1829.

¶ Hence Lord Bacon truly says of graftings, "The scion overruleth the graft, the stock being passive only." "This, as a general principle, remains true. The scion is endowed with the power of drawing or forming from the stock the particular kind of nourishment adapted to its nature, while the specific characters of the ingrafted plant remain unchanged, although its qualities may be partially affected."—Edinb. Encyc. Art. Hort.

apparently far less than vegetables. The productivity of animals cannot be increased like that of plants. The human capacity for progression is not more clearly visible than that of which so many vegetables have been found susceptible, that it may not unreasonably be inferred to be a law of their constitution. Very agreeable, but surprising, transformations have arisen from this property. The rose is the product of cultivation. The original plant from which all our beautiful varieties have proceeded is considered by botanists to be the common wild brier. Our plums are the cultivated descendants of the sloe; the peach and nectarines, of the common almond-tree; filberts are the improvements of the wild hazle; the delicious apples, whose species may be now reckoned by hundreds, are the cultured successors of the small austere crabs and wildings, which swine will scarcely eat; the original pear is a petty fruit, as hard and crude.* Our corn was once in a state very like grass; our cauliflowers, cabbages, and other domestic vegetables, are the artificial products of human skill and of vegetable improvability.

It is this undiminishable and undecaying property in plants which may rescue us from that chimerical dread of a superabundant population of the earth, under which we have been labouring for the last thirty years, until Mr. Sadler's tables, calculations, and reasonings have at last rescued us from it.† A great mistake has been prevailing on this subject. The true law of nature was misconceived. Partial effects were taken to be the general rule, and the real agency greatly overrated; and thereby an imaginary law has been assumed, which has never operated as was alleged. In nature, the law of population has never exceeded that of the productive power of vegetable life, and never will.‡

* Quart. Journ. Science, 1827, p. 272. Lit. Gaz. No. 691.

† I allude to Mr. Sadler's "Law of Population," published in 1830, which has thrown at last the steady and animating light of truth on a darkened and much mistaken subject. Some principles of the same sort were expressed in the History of the Anglo-Saxons, vol. i. p. 407, 5th edit. 1828.

‡ But though I think Mr. Malthus has erred both in his premises and conclusions, yet I wish to express that I feel strongly his active talents; his desire to explore an important subject, his wish to do service to society upon it, and the great benefit which his works have produced by their collateral illustrations, and by rousing mankind to study, as they have since done, one of the most important branches of political economy.

All that concerns human beings has been made upon a principle of benevolence. The same principle continues the system and superintends the working, and will always adapt the provision to the necessity, and supply further assistance if new exigencies should require it. But nothing supernatural on this point is likely to be wanted. Cultivated produce has hitherto outrun population in every country, and there is every appearance that it will always do so.* Two laws are visibly in operation in nature; one, that it shall not produce spontaneously—the other, that its produce shall be always increasable by human labour and skill. Ordinary, but diligent, exertions of these have hitherto abundantly sufficed for all that has been needed.† Local

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The intelligence with which he handled his subject struck me so forcibly that I expressed my early sense of it in a note to the First Part of the Saxon History, in 1799; but mature consideration satisfied me that he had mistaken the true principle, and that his inferences were therefore incorrect.

* I infer this from observing from the publications and complaints on the Continent—of most countries—in 1830, stating that they had more produce than they could sell, and censuring the corn laws of other countries that repress importation. This occurred at a period when the same countries were, by their statistical tables, all increasing in their own population. Yet still in all the produce was more than they consumed, and they sought to export for the chance of better prices than their home ones, from those places where, from other causes, these were higher than their own.

† Thus Humboldt found the natural produce of wheat in different countries, with all the carelessness of their indifferent cultivation, to be:—in Germany and Poland, 5 or 6 for one; in Hungary, 8 or 10; in La Plata, 12; in North Mexico, 16; in the equinoctial Mexico, 24; in New Granada, 25, and in fertile years 35. So in Greece it is 12 for one, and on the best soils even 15 or 18.—Encyc. Brit. Suppl. p. 508, 571.

Of Cape wheat 50 grains produced 4,074, or 80 for one; and in Barbary wheat 225 grains, sown in March, yielded in August 11,500, or 50 for one.

In BARLEY, one sort (called naked) gave 56; the Siberian, 111; the celeste, 120; the hexastichon, 130 for one; and the Philadelphian OATS, 140 for one.—Bull. Univ. 1829, p. 111.

Heshbon wheat, a new kind lately brought from Arabia, has ears twice as large as the common kind, with 84 grains in one ear.—Cambridge Journ. Aug. 1829.

Le sarrasin de Tartarie, brought by a missionary from Siberia, gives for one grain sown, up to the number of 2000 grains in *good* lands. Elsewhere, it bears from 50 to 300. It produces a better meal, and can be kept as well as corn.—Bull. Univ. 1827, p. 166. Dandini mentions the clusters of the vines of Lebanon to be enormous, and the grapes themselves as large as cherries.

In Hungary, the vegetation is peculiarly vigorous. Csaplovic has

distress may arise from temporary seasons and want of intercourse, but never from a failure in the powers of vegetable nature.

The extraordinary instances of the productiveness of nature, which even under the usual course of things frequently appear and can be produced, are sufficient to dispel all injurious doubt and unmanly apprehension, by showing us that plants, even as they are now, yet possess the most gigantic possibilities of productive power.* Such

recently stated as instances of it which have occurred, that 6 or 8 Hungary plums weigh one pound; as 18 cherries were seen to do in Yemen. In Beregh, apples have been of one pound and a half; and firs attain there a height of 216 feet, and a diameter of more than 6; oaks 114 feet, with a similar diameter; maples, 84 feet high, and 34 round.—Bull. Univ. 1830, p. 444.

In some part of South America, the bamboo attains a gigantic size, and the passion-flower assumes the character of a large tree. How the Indian banyan or fig-tree multiplies itself by its descending branches into arches and groves of new ones, as they take root in the earth, is well known. One tree has covered an area of 1700 yards.

The marine plants of Staten Land are described by Captain Webster as gigantic. And in Sumatra the rafflesia parasite bears a flower which is a yard in diameter. The same island has a tuberculous and alimentary root that weighs 400 pounds; and melons and gourds half as big. There the chama gigas appears, a shellfish called the Dutchman's cockle, one of which would sup twenty-four hungry persons.—Quart. Rev. No. 67, p. 522.

"Some of the *reeds* of Brazil, called gaquarussa, grow from 30 to 40 feet high, with a diameter of six inches. They form impenetrable thickets, and are grateful to hunters; for on cutting off such a reed below the joint, the stem of the younger shoots is found full of cool pleasant liquid, which immediately quenches the most burning thirst."—Lindsey, Nat. Bot. 303.

"The best fodder grasses of Europe do not rise more than three or four feet from the ground; but the panicum spectabile of Brazil grows six or seven feet high; while other equally gigantic species constitute the field crops on the banks of the Amazons."—Linds. *Ib.* 304.

* I allude to the instances of unusual produce which happen in some parts every year, and which I have noted from the daily papers: as,

OATS.—An oat stalk taken from a field on Sealand, near Chester, had 237 grains. Another, on a field lately part of Cockermouth Common, had 251. A wild oat at Milton was 10 feet high, and had 150 grains. One ear of black oats at Mansfield was 15 inches long, and contained 283. In 1824, a single grain of oats having fallen on a quantity of burnt clay, produced 19 stems, and 2945 grains.

WHEAT.—A single grain of Talavera wheat sown in a garden at Weston, near Bath, in September, 1819, had in August afterward produced 73 stalks, and yielded 7445 grains. One of the greatest increase of *wheat* that I have met with is that mentioned in the Philosophical Transactions. Mr. Millar, by repeated divisions, obtained from a *single seed* of wheat 500 plants, which yielded 21,109 ears, and about

effects have arisen, from a combination of local circumstances that have not yet been studied. The phenomenon is admired when it occurs, but the natural cause is never explored. But they are demonstrations of the latent and indefinite productibility of vegetable nature, which make the dread that any increase of human population will cause famine a fanciful chimera: for no one will in this age contend that the industry and intelligence of the searching mind may not discover the means of imitating and obtaining the same results which temporary accidents have occasioned. The principles of nature will therefore never fail. But it will always be necessary for wise laws and individual equity and benevolence, in every country, to cause her bounties to be sufficiently shared by all its inhabitants. Her produce first comes into the hands of a few, under the social system of protected property; to be after distributed, through the thousand channels of the arts and industry, which civilization, as it advances, establishes in every country; and by the assisting hand of occasional beneficence, for the sustenance of all. Nature can only thus generally provide. She places her bounty in the fields; she leaves it to man to apply and to disperse, because human instrumentality can do this most effectually. This is accomplished by every one seeking some mode and path of social employment, in which each obtains his own support, and at the same time is contributing, by his individual talent, labour, and produce, to the comforts of others and to the welfare of the whole.

The instances adduced of the actual productiveness in the vegetable kingdom, and of their repeated though occasional exertions of it, are evidence to us that it has not

576,840 grains, weighing 47 pounds, all the produce of one single corn.—Phil. Tr. 1768, vol. lviii, p. 203. Thomson's Hist. Roy. Society, p. 68.

PEAS.—A dwarf pea sown near Stockton produced 88 pods, containing 386 peas. Another pea, sown at Cawood, had 105 pods, out of which 505 peas were taken.

A PEACH-tree in Lateham Garden produced in one year 1560 fine peaches, besides a great number thinned away in the early part of the season.

A white moss rose-tree near Ripon had 520 in flower, and 460 buds beginning to open. And a small rose-tree near Congleton had 2344 roses and buds. A common scarlet bean has produced 100 pods with five full-formed beans in each, making in such stalks from 300 to 500 from the single one sown.

been formed on any confined, restrictive, or deficient plan. The spontaneous produce is always more than enough for the small or indolent population that is contented with it. But it is endued with a latent power of extensibility—with a faculty of increasing its produce as the wants and diligence of mankind may multiply: and thus we are assured from heaven itself, by these occurring instances of extraordinary fertility, that nature never will be found unequal to answer any demand that human necessity may make upon it.

These occasional exuberances of individual plants deserve also our notice, as important illustrations of the improving nature, of the progressive power, and of the extensible, though usually quiescent, energy of that living principle which actuates vegetation and forms all its products, but which as yet conceals its real essence so carefully from our view.*

The vast abundance of seeds which this animating causality is everywhere producing in many plants, even in common ones, is another specimen that this energy, and the obedient organization in which it is subsisting, have been both formed with a capacity of enlarging into a pro-

* It is rather remarkable, that just as European population was about to receive that steady increase at the beginning of the seventeenth century which has been since generally progressive, the potato should have been discovered. This has been as great a donation to mankind as the invention of printing, the cotton mill, or any other social comfort; for I observe from Sir John Sinclair's statement, that although the proportion of meal in a pound weight is but one in *potatoes* to two and a half in wheat, yet oatmeal is but one and a half, and barley only one and a quarter. But the proportion as to the quantity of nutritive food in either turns to the advantage of the potato; for he adds, that *an acre of land* will produce, in potatoes, 2700 pounds of flour, but in wheat only 1300 pounds. Thus the same extent of ground produces in the potato twice the quantity of nutritious aliment to that of the wheat. But in addition to the flour of the potato, he also asserts that the other part of it, the fibrous matter, can be made into puddings with milk, and into bread with wheat. Twenty-one pounds of wheaten flour kneaded with twelve pounds of the fibre of potatoes, will produce, when well-baked, thirty-eight pounds of excellent bread. When we consider that such potatoes are the improved produce of the petty, half-poisonous root of South America, we may perceive what great productive powers and supplies may be now lying dormant in other parts of the vegetable kingdom, ready to become active for human use, when human skill and diligence shall have explored and trained them. Hence, while the present system of nature is continued, mankind cannot be famished.

ductibility, whose limits we cannot fix,* and into a magnitude that sounds romantic.† But the number of flowers which nature in her general course, unstimulated by art, prepares and effuses from some trees, approaches the scarcely credible class of things.‡ These surprising multiplications of the living principle in plants mark its high origin; and from their baffling all human explication, prove how little its recondite, yet powerful, nature is understood.

In the alimentary plants, the great care for providing an ever-succeeding sufficiency of human subsistence is manifested in all regions. In some, the same tree which affords it bears the produce of different seasons on its branches.§ This phenomenon is occasionally, though imperfectly, manifested in our own country and on our common trees; thereby indicating the possibility of our imi-

* The two stamina of the orchides fecundate 8000 seeds—and the five of the tobacco 900. Loud. Encyc. 226. The quantity of small seeds from garden flowers is well known. But Mr. Hobson found that a thriving plant of the common malva sylvatica yielded in one summer 200,000 seeds. Phil. Trans. 1743, vol. xlii. p. 3, 20. It has been computed that if all the successive seeds of a single fern, of one peculiar sort, were to germinate without obstacle, this species would in twenty years cover *the whole globe*.—Bull. Univ. 1829, p. 438.

† "Man, improving on nature, produces cabbages and turnips of half a hundred weight, and apples of one pound and a half."—Loud. 263. . . . . Every vegetable product seems capable of an enlargement that would be incredible, if such things did not frequently occur. Thus we read of a strawberry seven inches round—a lettuce weighing four and a half pounds—an apple fifteen inches round, and weighing nineteen ounces—another twenty-five ounces—a bunch of grapes weighing fifteen pounds—a mushroom above a yard round, and weighing nearly two pounds—a pear of two pounds weight—a black currant two and a half inches round—a gooseberry three and a half inches—a melon, of superior flavour, weighing eighteen pounds—a cauliflower nearly sixteen pounds. All these in the soil and climate of England. . . . . In 1824, a pear-tree at Carluke in Scotland, thirteen years old, in the spring protruded a number of young shoots, which in the *same* summer bore fruit, some of this as large as that on the elder branches.

‡ Thus a single spatha of the DATE, the chief food of North Africa and the desert, contains 12,000 male flowers. The alfonsia amygdalama has 600,000 upon a single individual; while every bunch of the seje palm of the Oronoco bears 8000 fruits.—Lindsey's Nat. Bot. p. 280.

§ "The breadfruit-tree in Tahiti produces three and sometimes four crops a year, and many hundreds of fruit at a time. The several varieties ripen at different seasons, so that there are but few months of the year in which ripe fruit is not to be found in the several parts of the island."—Ellis Polyn. i. p. 357. The cocoanut there is still more continual. Fruit *in every stage*, from its first formation to the full-grown nut, may be seen, *at one* time, on *the same* tree, and frequently on the same branch.—*Ib.* 366.

tating such extraordinary successions of produce by increasing skill and cultivation.* But the fact has been, that nature has always, under the smallest exertion of human thought and labour, produced so much more than society has wanted, in her vegetable food, that no art has been less studied, until lately, than that of agriculture, and none so little improved. No stimulus has been great enough to urge mankind to watch, and try, and pursue it with the diligence and scrutinizing judgment which have so highly advanced the mechanic arts, and effected such wonders in the sciences.† Even still many tribes choose to be content with Nature's spontaneous produce, which is always scanty, as if to compel our industry to exert itself; although the living principle implanted in vegetation is quite ready

* Thus in August, 1829, two apple-trees at Cheltenham were covered with blossom, though bearing at the same time a fine crop of fruit.—In July, 1821, a pear-tree at Canterbury had a large quantity of fruit, while the other parts of it were in full bloom.—In the same year, a pear-tree near Winchester blossomed in May, and the fruit of that was fine and full. It bloomed again the next month, and the fruit reached the size of an egg. In July, new blossoms appeared, which made fruit as big as a walnut. In August, flowers again emerged, but the produce was not larger than peas. These were Nature's own exertions, which art might in time promote and make more effectual.—In the same year, an apple-tree blossomed three times, and with ripe fruit twice.—Strawberries have had blossoms and good fruit twice in some seasons and places.

In September, 1821, the Siberian crab-tree before my window had an unusual quantity of its full-grown apples, and was then also shooting out twenty fine white flowers, which were blossoming in October, though the leaves had nearly all fallen off. So in a friend's garden near, an apple-tree was full of fruit, and also of its second blossoms. Many pear and apple-trees reblossomed that year. Red strawberries in the same year produced in October a second crop of ripe fruit, in several places. They flowered fully in my own garden, but the fruit did not swell; but they were picked that Christmas from some other garden beds. At a parsonage in Herts, at the end of the same December, the following flowers were gathered:

A white rose-bud, A large full-blown campanula,
A full-blown red rose, A polyanthus in flower,
A sprig of hawthorn in flower, Purple heath in flower, and violets.

Roses were flowering in other gardens.

† Thus the Otaheitians will not cultivate the valuable ARROW-ROOT, because it costs them some trouble. Though capable of being procured in any quantity, it requires *some labour* to render it fit for food. On *this account*, it was not extensively used by them. It formed rather a variety in their dishes at public feastings, than an article of general consumption.—Ellis, p. 361. Their YAM also, "a most valuable root, is cultivated to no very great extent, from the labour and attention it requires, although it is one of their best-flavoured and most nutritive roots."—*Ib.* 360.

to answer any demands that may be made on its productive powers, by any augmentation of human population.* It only requires that human art and industry should be increased in this branch of our necessities as much as they are in the less essential one of our luxuries; and then its supplies will never be inferior to the need. This has hitherto always occurred in some degree. Want has stimulated the mind to greater art, care, and industry in these northern climates; and the superiority of their population, sustenance, and comforts is visible to every observer. Enlarging numbers only magnify the effect; for mankind seem to thrive and civilize in proportion as they multiply; and, by a recurrent action, to multiply again in proportion as they civilize and prosper.†

I have taken this rather copious view of the productiveness of vegetable nature, and collected these facts and circumstances for your consideration, because until they occurred to me I found that I had not formed just notions on this important branch of the great system of our creation; and the deficiency which had subsisted in my own mind and judgment may be removed from yours by the recapitulation and recollections into which I have diverged. But it only is from an adequate adduction of particulars that our general views can be either large or full. Nature is expanded before us every day; but we must minutely observe it, in order to comprehend it; for we have to ascend

* When the Tahitians (Otaheitians) were exhorted to adopt the comforts of Europeans, they answered, "We should like these things very well, but we cannot have them without working; *that* we do not like, and therefore would rather do without them: the bananas and plantains ripen on the trees; the pigs fatten on the fruits that fall beneath them. These are all we want. Why therefore should we work?"—Ellis, Polyn. Res. vol. i. p. 451.

† This is satisfactorily illustrated in Mr. Sadler's publication. The missionaries found that they could make no progress in civilizing the Tahitians but by causing wants to arise in their minds. Ellis says, "The absence of all inducements to labour increased the difficulty. Their wants were few. Their desires were limited to the means of mere animal existence and enjoyment. These were supplied without much anxiety or effort—and possessing these, they were satisfied." ... "All classes were insensible to the gratification arising from mental improvement, to the enjoyments of social and domestic life, to the comforts of home, and to the refinements and conveniences which art and labour impart." ... "To *increase these wants*, or to make some of the comforts and decencies of society as desirable as the bare necessaries of life, seemed the best incitement to personal industry."—Pol. Res. 451, 452.

from the phenomena to the principle, and to infer the plan from its execution. It is thus we learn to know the productive laws of its original system, by a patient notice and accumulation of its ever-evolving effects.

But if human ingenuity has been hitherto dormant on the vital point of its bodily subsistence, it is now presenting us with indications that it will be indolent and inattentive no longer. Experiments are beginning on the long-neglected art of multiplying human food—and even of obtaining it from other vegetable matter, besides the farinaceous grains and roots of nature. A German is stated to have found out the means of converting sawdust into an eatable food.* A medical gentleman, near Manchester, is making bread from turnips, carrots, parsnips, and beet;† and a French miller has ground and worked straw and hay into nutritive bread,‡ not inferior to that which the largest part of the Continental multitude subsist on.§ If it were not for this intimation, we might think that these inventions would only bring us back to the state of ruder times, when human subsistence was of this coarser kind—enough

* Sawdust may be converted into a substance like bread. It is less palatable than flour, yet makes a wholesome bread, digestible and highly nutritive —Dr. Prout's Account of Prof. Autenricht's Experiments, in Phil. Trans. 1827, p. 381. Hersch. 65.

† The public papers of March, 1830, stated that Mr. Gouldson had discovered a mode of separating and preparing the farinaceous parts of such bulbous roots as turnips, carrots, parsnips, beets, &c., and of converting it into a fine flour. After two years' experiment, he has now obtained a patent. He declares that he really produces good and nutritious bread, equal, both in quality and colour, to the finest white wheaten bread. The quantity of farina to be obtained from the roots grown upon any given quantity of ground, compared to that produced from the ears of wheat on the same space, is increased, he says, at least twenty times.

‡ This last discovery is thus noticed in a highly respectable French periodical work devoted to the sciences. "Chance led a miller in the Côte d'Or, to discover the means of converting STRAW into a farine of pretty good quality. Lately the Duc d'Angoulême, passing through Dijon, tasted some small loaves made of it, and took some to show the king. It was M. Maitre, founder of the agricultural establishment of Viloffe, near Chatillon, who first discovered it. He has since found that not only the straw of corn and other grains may be made into flour,—but that hay, and the stalks of trefoil, lucerne, and sainfoin are also convertible. Flour from these last he gives to his sheep and lambs."—Bull. Univ. June, 1830, p. 157.

§ The Moniteur, in May, 1830, mentioning that wheat straw, chopped and ground, yields a flour that was coarse, but agreeable and nutritious, added, that its bread was *superior* to the *common* bread used by the lower orders on the Continent.

to support what was then deemed comfortable life, but not to give it the pleasure and the improvement of superior food; for there is a food, and a course of prudent diet, which is more favourable to the intellectual energies and to the moral sensibilities than any other. This seems to be in the golden mean between deprivation and exuberance.

"Spare fast that with the gods doth diet"

was the experience and the encomium of our Milton; and a moderate use of selected and improved articles of sustenance may give the strongest wing to genius, and the sweetest temper to the habitual spirits. But the most essential condition, in a daily enlarging population, is a sufficiency of that which will support bodily strength, and nourish the vital principle. The simplest food will always do this; and if all vegetable produce can be made so to act, and yet be palatable, the inventor of such conversions will be a benefactor to mankind. Wheaten bread is a desirable enjoyment—but other vegetable food cannot be unpleasant, since our ancestors lived on barley cakes; the Russian still on his hard black rye bread; the Scotch love their gratifying oatmeal; and the Irishman his potatoes. Even acorn food is yet palatable to some people, who might have corn if they would cultivate it.* Some nations can be content with far worse materials of nutriment,† and others resort to what we should most zeal-

* Thus Captain Beechy mentions of the Indians he saw in California, that they cultivate no land; but "acorns, which abound, constitute their principal food. They bake them, and bruise them between two stones into a paste, which will keep dried until the following season."—Voyage to Pacific. So Desfontaine remarks on the people of the Atlas Mountains between Algiers and Morocco:—"They have oaks on whose acorns a number of the inhabitants of these cantons subsist."—Bull. Univ. 1830, p. 469.

† In New-Zealand, "the *fern root* furnishes a principal part of the food of the common people, at some seasons of the year."—Ellis, Polyn. Res. vol. i. p. 34. At various times in Europe, when scanty harvests pressed, the poorer of the poor have made their bread of fern roots. Evelyn notices that burrs and thistles have been used for human food. Bruised thistles have been often given to horses in France, who have fattened on them. The Laplanders, when pressed, make bread from one of their mosses. In France, in 1817, the continued rains of the preceding summer having prevented the corn from ripening in one of the departments, the people for several weeks before the next harvest

ously reject.* Now we find that even DRY BONES may be made serviceable as human food.† But the number of new things made from vegetables only, in the last twelve months, not only amuse us as we read of them, but contribute to illustrate the utilities, both for food and conveniences, that are yet additionally derivable from them.‡

were reduced to live solely on herbaceous vegetables, as goat's-beard, wild sorrel, nettles, thistles, bean-tops, and leaves of trees: these were chopped up, boiled, and mashed; if too old to be so eaten, the juice or pulp was expressed from them. But, not being accustomed to such food, the continued use of it produced in many a species of dropsy.—Journ. Phys. Experim. 1822. In the scarcity in Ireland, in 1818, nettles and all other eaculent herbs, with the coarsest bran, were resorted to for food. This also produced feverish illnesses.

* The natives of New-Holland are estimated at three millions, yet "agriculture is unknown among them. Their food is frequently scanty and loathsome, consisting sometimes of grubs and reptiles taken in the hollow or decayed trees of the forest."—Ellis, Polyn. Res. p. 22. Here man will not help himself. Many uncivilized people will not cultivate the earth. Their deficiencies of subsistence are therefore their own wilful fault. They prefer any privation to personal labour.

† "Dry bones may be converted to nutriment by steam, or by a cheap acid."—Dorcet, Ann. d'Industrie, Feb. 1829. Hersch. p. 65. This reminds me of what I read at seventeen, of Papin's Digester dissolving bones into an animal jelly, in our worthy and ingenious Oliver Goldsmith's Animated Nature. By this and by his other works, he then gave me too much pleasure to be easily forgotten.

‡ Thus M. Du Chatelier announces that he has discovered the means of so preparing all the leaves of trees and plants as to make them excellent TOBACCO; especially the nut and vine. The powder is as sternutatory as the nicotian, but does not produce the vertigo which tobacco snuff occasions.—Bull. Univ. 1830, p. 342. So another, with the aid of a little malt, makes what he terms good BEER from *potatoes*.—*Ib.* p. 348.....A gentleman of Vienna has found that *elderberries*, in equal quantities, yield more BRANDY than the best wheat.—*Ib.* p. 121.....Another disserts on the advantages of feeding CATTLE on the leaves of the elm, acacia without thorns, ash, and poplar.—*Ib.* p. 224.....Another, by hand-nets with bags, caught from his corn five bushels of GRASS-HOPPERS, which he boiled. They turned red, and made a friand repas, a delicious repast to his PIGS.—*Ib.* 1829, p. 235.....Another experimenter found that sweet potatoes would form wort, ferment, and make, like malt, good beer, in flavour exactly like ale made from malt.....Another raised on light lands, that grew only 327 bushels of potatoes on the acre, 640 bushels, on the same space, of JERUSALEM ARTICHOKES, which the young calves ate with rapidity, and improved upon; so did horses and sheep, and pigs too, but not till boiled or steamed.—Farm. Jour. 1829. .....The seeds of GRAPES, pressed and boiled, furnish a liquid very like that of COFFEE, and much used for it in Germany. The seeds of the yellow iris, roasted, are also declared by Dr. Johnson to make excellent coffee.....The seeds of FOREST BROOM are said to have the same quality.—Public papers, 1829.....Lately we have heard that the vapour from all baked bread has been collected into an ardent spirit

All these facts lead us to one and the same conclusion, that no population that will think and labour, however numerous, can ever starve from continued want, under the present system of vegetable nature. The Great Author may choose, through his atmospherical agencies, to disappoint, by occasional vicissitudes, the expectations of his intelligent creatures, when they are forgetting the primal Cause and Giver of all that they are enjoying—but these are only temporary and partial corrections. The principles of vegetable nature never alter—nor has their produce ever in any age universally failed. By commercial or benevolent intercourse, we can therefore always assist each other's needs, when these assumed or permitted interruptions occur in any particular district or country, as we have done more than once to Ireland—and also to Hindostan. Their rice at times has failed in parts in the one, and their potatoes in the other—but the rest of the world were at the same time enjoying their usual plenty. Hence in no case have mankind, at any period, been under the danger of generally perishing for want of sustenance; nor under the universal laws of vegetable nature, as established at the creation, and still continuing, can such a catastrophe at any time occur. A special miracle of annihilating displeasure can alone produce, under our present system of being, a desolation of this nature. Away, then, with all the dread and spectres of human starvation from multiplied population. Let religion improve and guide our social spirit; let wisdom characterize our laws, and integrity conduct their administration; let enlightened policy and sound moral principle superintend, and regulate, and assist the distribution and individual acquisition and application, of what nature will always sufficiently produce generally for all; let reasonable diligence and care have always the means of obtaining what is fairly needed; and let nations have intercourse with each other as unrestricted as the public welfare will allow; let due recollections of the Great Benefactor of all accompany with these provisions our daily life; and no portion of mankind, by whatever multiples they may increase, will ever find that they are over-

somewhat resembling gin. Thus there seems no end to the valuable matter which vegetables may, by art and labour, be made to yield for human use.

passing the productivity of nature, nor will ever be destroyed by its defective supply. Dryden exclaims of himself—

"I live a rent-charge upon Providence."

So do we all—we are all a rent-charge upon our Maker's care—but if we duly feel this truth, and conduct ourselves conformably to the impression, we shall find that it is such a rent-charge as will never be left in arrear, but be always punctually and munificently discharged. Such has been my personal experience, without any native, peculiar, or other advantages, beyond those which are common to us all. Such, I hope, will be yours; and such your verdict, at the same mature age, on that benign administration of earthly affairs under which we are both living, and by which we and all are hourly benefited.*

* Since I wrote these Letters, I have seen Mons. de Luc's Letters to Blumenbach, on the Physical History of the Earth, with Introductory Remarks by the Editor, the Rev. H. de la Fite. Both parts contain very important illustrations and confirmations of the Mosaic cosmogony; but I will only notice here M. de Luc's conclusion from his reasonings, as to the agency of light commencing with the beginning of creation, which a former Letter pointed out to your attention. "Nothing of all that we see on the globe could begin to be operated, without the union of a certain quantity of LIGHT to all the other elements of which it was composed; elements which, without it, would have exercised no chymical action on each other. Accordingly, all the known geological phenomena date their origin from the time of this union."—De Luc's Lett. p. 79, Lond. 1831. This is a principle deserving the most scientific consideration and investigation. It will probably become more obvious as our chymical knowledge enlarges. He also adds the important truth which presents such a verification of the Mosaic account: "The light first introduced into the mass of the earth did not proceed from any luminous body like the sun."—P. 86. This grand physical truth could not have originated 4000 years ago from any *human* mind. It is in opposition to all ordinary sensation.

LETTER V.

Inferences from the preceding Facts—No spontaneous Production of Plants—Their reproductive System.

My object in the preceding Letter has been, as it will be in the continuation of the subject in this, to select and notice those phenomena of the vegetable kingdom which will give you a just and enlarged idea of the principles on which it has been formed, and of the peculiar nature which has been purposely assigned to it. It is necessary that we should have right notions of the system on which our earth has been framed, and of the plan and purposes of all its departments, in order to perceive what the Divine mind has intended by our terrestrial creation, and thereby to judge more soundly on the great component whole. This knowledge will assist us to appreciate his ends and operations in the course of nature which he has established, and in the direction and application of his providential economy to ourselves, as well as to our inferior fellow-creatures. The more fully we know and the more justly we think on the vegetable and animal kingdoms, we shall be the better prepared to comprehend the principles and the history of his dealings with the human race. This world is manifestly not our world only. We are linked in it with innumerable fellow-beings, of very varying kinds and qualities. They are cotenants with us of our common earth. We cannot live in it without their association and services. Relations therefore subsist unceasingly between us, which cannot be destroyed without destruction to ourselves; and from this view of the real state of things, it is an object of great intellectual interest and importance to become acquainted with the most material phenomena of these classes of animated nature, however dissimilar and subordinate they seem to be to our more gifted order. Do not, therefore, think me tedious if I particularize a few more facts on this curious subject, with such reflections as have arisen on a mature consideration of them.

From all the circumstances thus far enumerated, we may infer—

That the vegetable classes have been created upon a system of progressive improvability—and also of an indefinite productiveness, which can be increased to the utmost extent of any probable human demands upon it.

That the application of human skill, care, and diligence to educe these beneficial results has been made the condition of their appearing; but that these valuable qualities will never be exerted in vain on this interesting order of beings.

That human welfare and comfort have been a principal object of the Creator in designing and producing his vegetable world, though it has been also made subservient to animal subsistence; and that these are peculiarly connected with the cultivation of it. Animal food leads to the animal habits of hunting and pasturage; both of which, though pleasing as occasional employments, yet when made the character and chief pursuits of a tribe or nation, tend to animalize our nature and arrest our social progress. Ancient Scythia, and the modern Tartars and Arabs and North American Indians, are commentaries on this principle. Agriculture and gardening, and their consequential occupations, accustom the human mind to the quiet, patient, contented, domestic, social, and civilizing habits on which human happiness and improvement mainly depend.

The vegetable kingdom, in its varied flowers, foliage, stems, and graceful and delicate expansions; in its playful branches and gentle movements; and in its multiplied fruits and useful products of numerous sorts and of universal application, display a peculiar goodness, liberality, and kindness in the Divine mind towards his human race—a desire to please, to interest and to amuse us with the most innocent, continual, accessible, and gratifying enjoyments. For, plants peculiarly address themselves to three of our most used senses—the taste, the smell, and the sight; while the ear is also soothed by the whispering of the branches,* and the touch by the softness of the verdant and floral foliage, and of most of the fruits. We see that the consolidated

* As schoolboys, we have all felt how truly and how sweetly Theocritus sang—

Αδυ' τι το ψιθύρισμα καὶ ἁ πίτυς, αἰπολε, τήνα
Ἁ ποτὶ ταῖς παγαίσι, μελίσδεται.

Sweetly the whispering leaves and waving pine
Melodious sound among these fountain rills.—Idyll. 1.

wood supplies us with numerous conveniences of private and public use; and from plants has arisen that most needful and comfortable of all things beyond the limits of the torrid zone—the grateful warmth and use of our domestic fires. Even in this respect we may perceive that there has been a benevolent foresight and provision specially exerted, in order that this daily comfort might continue to accrue to us, after our diffusing population should have levelled the forests which supplied the fuel. Buried in the earth just deep enough to remain unknown till wanted, that primeval vegetation which was overwhelmed and uprooted by the deluge has during its long sepulture become converted into bituminous coal, sufficient to yield us fire for all our purposes, though every wood should be consumed, and mankind last for more ages than they are likely to continue.* In this beneficial supply of a mineral so invaluable we have an instance of a great destruction directed by a prospective benevolence, to prepare and produce for a future age one of the kindest additions to human comfort. What a demonstration of the most deliberate goodness presiding amid the most awful displeasure!

It is of peculiar importance to our reasoned comfort—to that happiness which we derive from our intellectual convictions—that we possess, in the beauties and blessings of the vegetable creation, such universal and exuberant witnesses to us of the benignity and philanthropy of the Divine Creator. They not merely reveal his general goodness, but a real love and sympathy towards mankind—a personal kindness to us, intending to be so and acting as such, merely to please us. The flowers, fruits, and foliage, the forms,

* Coal has been hitherto found most extensively in the British islands: the next in importance is near Liege. It is also in Misnia, Hungary, Silesia, Bohemia, Upper Styria, and France. It has been discovered in America in various parts, and also in China, the Birman empire, Great Tartary, and New South Wales. "It is probable that nothing is yet wanting in many other parts of the world, but knowledge, industry, wealth, and the stimulus of want, to prove that it is a far more common substance than it has hitherto appeared to be."—Dr. Macculloch, Geol. vol. ii. p. 308. Thus it is almost everywhere made and kept ready to come to human knowledge and use in each country, as soon as it shall be wanted; and if any one district does not possess it, that can be abundantly supplied by its neighbours who abound with it. Such has been the extraordinary provision made for human enjoyment, as it was foreseen it would be wanted. It is disclosed to human search, just at the times when the discovery is most serviceable.

qualities, and motions of nature's verdant kingdom, in all their luxuriant diversities, have been purposely made what they are, purely to give us the pleasure they excite and the benefits they convey; for if our mere subsistence had been alone his object, we see that grass, hay, straw, acorns, and sawdust would have answered that purpose. What the savage lives upon in full strength and activity every child of man could subsist on; and be as happy as all the animated tribes appear to be.* But he has not so dealt with us. We never act towards each other, in our kindest moments, with that inventive, foreseeing, and persevering benevolence which has been exerted by our Maker in the formation of his vegetable system: and this benefaction is still in all regions reproduced at every vernal and autumnal season. But not one single plant or flower could have existed, unless its qualities and products had been specially designed and resolved upon beforehand, and the needful consideration exerted, as to what variation of means and organization would occasion the specific result. Every flower we handle is an evidence to us of this particular anteceding deliberation, and therefore of the kindness to mankind which suggested it. Without the generous intention to give us pleasure, abstracted from all benefit to himself; and without the special resolution to vary and multiply it; and without the actual exertion of lavish imagination to devise the distinct form and nature; and without the previous combination and perception of the means that must be employed to bring it into being, with all its properties and effects; not a single flower, not one plant or tree, could have existed. And yet they have all been created with such an exuberance, that not only every peopled country swarms with its own beauties and benefits of this description, but heaths, and deserts, and uninhabited islands, and mountains scarcely accessible, have been made to have their peculiar and interesting vegetation, though not immediately used by man; as if it had

* How little and how simple a diet would have supported human life in comfort and activity we see from this passage: "A LAPLANDER will go thirty miles through swamps and rocks; take *a draught of milk*, sleep in his wet clothes, and rise the next morning *as fresh* as when he began his journey."—Everest's Journ. through Norway. Mr. E. speaks warmly of the Laplanders' high state of health and spirits; which he ascribes to their total absence of mental anxiety, to their few and simple wants, and to their hardy habits.—*Ib.*

been foreseen that no place would be so forlorn or repulsive, but that the curiosity, or occupations, or vicissitudes of society would be at all times urging some individuals to explore it. When they do so, they see the new indications of their Creator's existence and providing care; and often transplant to their own homes and countries whatever they find useful or admire. We know that this has been done. Travellers have at various times pervaded such localities; and botanical students have been, and are, searching the farthest recesses and deepest solitudes of the world, to discover and make known to their contemporaries the yet unseen treasures of this department of the Divine creation.* Even the bleakest and most barren extremities of earthly soil, where frost, and snow, and desolation seem to have fixed their stern dominion, have been visited, and their plants examined.† Linnæus found the provident liberalities in the home of ice and snow;‡ and some of our best virtues are there the companions of what we should call extreme pov-

*The perilous precipices and towering peaks of the Alps, the Atlas, the Ararat, the Balkan, the Andes, and the Hamalaya have been repeatedly visited for the purpose of exploring their vegetable species. Tournefort, Saussure, and Humboldt were among the earlier leaders; but a long train of followers have since emulated their spirit, labours, and scientific abilities. The deserts of Africa, the pampas and forests of South America, inhospitable Japan, and jealous China have now been traversed by the resolute activity of the ardent naturalist. Such intellectual energy confers more real honour, both on the individuals and on their nation, than any military exploits, although these may have their occasional uses or necessities. But these are always to be lamented, even when most expedient; while science, if not separated from its great Founder, enables us more and more, as Milton says of Mirth to Liberty,—

To live with her and live with thee
In UNREPROVED pleasures free.—Allegro.

†Thus even New-Shetland, towards the confines of the antarctic pole has been visited, and its vegetable state described. The account is worth remembering, as one of the simplest conditions of vegetable nature, in its earliest and humblest commencement. "The land is naked and steril, with no trace of plants. In a few places a very small moss is with difficulty discerned. A lichen, the same as those on the heights of Cape Horn, comprises, with a few marine plants, the botany of New-Shetland."—Ed. Journ. Science.

‡I particularly allude here to the betula in the icy regions of the arctic pole, which is not less beneficial and grateful to the Laplander, than the cocoanut-tree to the South Sea islander, or the date-tree to the restless Bedouin of the arid desert. Linnæus is particularly eloquent and interesting in his description of the betula. He saw and felt its uses when he was exploring these abodes of frost and privation.

erty, but which they find full of comfort.* Nor can the philanthropy of this unexhausted beneficence be either doubted or denied. It is most special love to man—for brutes have not his enjoyment from it. The bird, and the insect, and the quadruped give us no perceptible indication that they are sensible of the beauties which delight our eyesight, and which charm us by their fragrance. Unless, then, our world be inhabited by an invisible race of beings,—fairies, genii, sylphs, or spirits—there are no intelligent beings but ourselves, to feel, to value, and to be regaled with the loveliness of vegetable nature. It has therefore been made specially, purposely, and exclusively for us; and in this view it is an unceasing testimony that the grandest and mightiest of all beings is the greatest and kindest Philanthropist that exists, and has been studiously careful to exhibit to us that he is so.†

And what an exhilarating consolation is this! For who is this Being, that so condescends—who thus reveals himself to us with features, and feelings, and qualities so gracious and so amiable?—nothing less than uncontrollable and irresistible Omnipotence! Nothing could be more terrible—nothing more dreadful to us, and to all sentient nature, than a being of his absolute, unlimited, and almighty

* Mr. Everest says of the bleak NORWAY, "I have *often felt* that I could live and die contented among its rocks and woods and dales, in the midst of its quiet and virtuous people. No one ever left Norway without regret. It is a country in many parts of which a child might walk about with a bag of gold, and no one would molest him: where the stranger, by day or by night, may knock at any door he comes to, and be welcome." Yet he describes them as "destitute of every comfort." With one large bed, like a deal box, into which they *all* creep, some straw is spread at the bottom, and sheep-skins serve for covering. Their wainscots are composed of trees, with moss stuffed in the chinks; and in some houses the *whole stock* of utensils were, one large pot, an axe, one knife, and half a dozen wooden bowls and spoons. Still they were very happy. "We usually found two or three religious books in every house."—Ever. Journ. Norw.

† Young's just lines deserve to be recollected:

> What, then, art THOU? By what name shall I call thee?
> Knew I the name devout archangels use,
> Devout archangels should the name enjoy
> By me unrivalled. Thousands more sublime;
> None half so dear as *that* which, though unspoke
> Still glows at heart. O how Omnipotence
> Is lost in love! Thou great PHILANTHROPIST
> Father of angels! but, the FRIEND OF MAN.—Night 4.

potentiality, if he were not as good and gracious as he is infinitely powerful. Nor would even general or abstract goodness avail us. Each human individual is so petty an object, compared with such stupendous majesty, that it cannot but be, at all times, a subject of infinite importance, whether the Lord of such multitudes of beings will be—is—or means to be—benign and kind to us. He answers this awful question to us all by his vegetable creations. Would a tyrant have produced them? Could they have arisen if he had been indifferent towards us?—if we had not been the objects of his kindest forethought and most elaborate care? No—his benevolent philanthropy comes to us with an expressive voice, and in a personal visitation, in every sweet flower and pleasing foliage around us—in every fruit and food that delight our taste or refresh our bodily necessities. They are manifestly intended to have this effect, or they would not have been thus created. It is us whom they benefit,—not their Great Provider;* and the special means that must have been originally put in action and kept in efficacious energy for the unceasing perpetuation of their races, and for their continued revival to us, are equal assurances to us that the same feelings which prompted their first fabrication are still predominating in the Divine mind, and will be there abiding and influencing it towards us, as long as the floral gems and treasures of our gardens, our fields, or our forests reappear with every spring and summer. These not only please; they also enrich us with the marvellous affluence which they are everywhere creating—although of this astonishing annual addition to human wealth and property we are generally very thoughtless and insensible.†

* The poet again combines eloquence, and poetry, and truth in all their richness, when he exclaims—

> O thou great Arbiter of life and death!
> Nature's immortal, immaterial Sun!
> Whose all-prolific beam late called me forth
> From darkness, teeming darkness, where I lay,
> The worm's inferior: high to bear my brow;
> To drink the spirit of the golden day,
> And triumph in existence!—and couldst know
> No MOTIVE, BUT MY BLISS.—Night 4.

† The annual riches given anew to mankind every summer, by the continued produce of the earth, would amaze us by their amount, if the whole could be ascertained and calculated. A few instances will imply

sonal decoration. Anacreon sweetly sings his delight from vegetable nature,*—and most enthusiastically of the rose,† —though he also twines the lily and the hyacinth round his forehead, as an attractive and festive ornament.‡ Their presence, and the scenery and companions which always surround them, have excited in many poets, of all nations, their finest thoughts and feelings.§ It has been a favourite theme to the imagination to fancy, or to sing, that herbs,

*Thus in his twenty-second Ode:—"O sit in this shade! That tree, how beautiful! On its most tender sprays, how it shakes its young locks! while the fountain near it, flowing persuasion, excites our attachment. Who that looks on this can pass away from such a place of repose?"

"Lo! how the Graces scatter roses on the advancing spring.—The shadows of the clouds are departing. The labour of mortals glistens. Earth is nurturing her fruits; that of the olive is just born, and the juice of the vine, blossoming from the branch and leaf, crowns it with its fruit."—Anac. Ode 37.

† In his fifth Ode, he calls it "The rose of the loves;—adapting to our temples its beautiful foliage. Transcendent flower!—Spring's fostered care!—a delight even to the gods!"

But in his 53d effusion he is most eloquent in its praise:—"With the flower-crowned spring, I sing the summer rose—the breath of gods—the enchantment of mortals!—the ornament of the Graces in the season of their floral loves!—the play-toy of Venus. Ever grateful to the Muses, how sweet to him who travels through the briery dells! How sweet to him who plucks it with gentle hand, to cherish it in his bosom—who lightly raises to his lip the flower of love! It is pleasant on the roof, and on the joyous table, and to the feasts of Bacchus. What can be without the rose?"—Anac. Od.

‡ "See how it becomes us to twine the white lilies amid the roses into chaplets."—Od. 34. "Entwining coronals of hyacinths round my temples."—Anac. Od. 42.

§ As in one of the delicious passages of MILTON, which has never been excelled:—

"Sweet is the breath of morn; her rising sweet,
With charm of earliest birds: pleasant the sun,
When first on this delightful land he spreads
His orient beams, on herb, tree, fruit, and flower,
Glist'ring with dew: fragrant the fertile earth
After soft show'rs; and sweet the coming on
Of grateful evening mild: Then, silent night,
With this her solemn bird; and this fair moon,
And these the gems of heav'n, her starry train.
But neither breath of morn, when she ascends
With charm of earliest birds; nor rising sun
On this delightful land; nor herb, fruit, flower,
Glist'ring with dew; nor fragrance after showers;
Nor grateful evening mild; nor walk by moon,
Or glittering starlight, without Thee, is sweet."
Parad. Lost, B. 4.

and flowers, and trees could sympathize with human sorrow.* The Greeks used flowers as part of their funeral tributes of regard;† and their priests consecrated to Iris the trees on which the rainbow seemed to rest.‡ The Turks preserve the ancient use of flowers as symbols of the language of the feelings, and make them the silent and secret epistolary messengers of their sensibilities,§—they also apply them lavishly round the graves of those they love, to express their attachment and grief.

But however fanciful these ideas and customs may be, they are evidence how eminently vegetable nature has at

* Thus Moschus, in his Greek hexameter epitaph on Bion, indulges the supposition of the possible sensibility of vegetable nature:—

"Mourn with me, ye plants! woods! now bewail!
Sigh, O flowers! from your sorrowing stems;
Blush mournfully, ye roses! anemone!
Hyacinth! now speak in your symbol letters,
And by your floral leaves more than common
Express your tokens of grief. The beautiful singer is dead!"
Μοσχυ Επιτ. γ.

So he apostrophizes his lost friend:—

- - - "At your dissolution,
The trees threw down their fruit, and
Every flower faded."—*Ib.* - - -

This seems extravagant: though Milton has partly imitated it in his Lycidas. But it may have been a belief of the Greek poets, since one of their few natural philosophers, also a versifier, Empedocles, could say, "The first of all animals were trees, and sprang from the earth before the sun enriched the world, and before days and nights were distinguished."—Plut. Plac. *e.* 26. . . . If Plato and Empedocles could teach "That plants are informed with a soul, and that of this there is a clear proof, for they tremble and shake; and when their branches are bent down by the woodman, they yield but to spring back again to their former uprightness" (Plut. *ib.*), we may believe that poets allowed them some sympathizing feelings.

† Thus Bion, in his Elegy on Adonis, exclaims,—"Bring Adonis, however ghastly—place him *between* the crowns and the flowers—but since he has been dead, all the flowers have withered!—v. 74–76. The poet expresses also these too-pretty fancies:—"But his remains have turned all things on the earth into flowers. His blood produced the rose; and his tears the anemone."—v. 65. . . . . The anemone was made by the Egyptians an emblem of sickness.—Hor. Ap. l. 2, c. 8.

‡ Plutarch informs us, "The rainbow clouds make the trees fragrant on which they fall. Our priests call these trees 'Iris-protected,' imagining that Iris takes care of them."—Symp. l. 4.

§ Lady Mary Montague was the first who made England acquainted with this custom of the enamoured Turks to make flowers their love-letters; their conventional meaning, when so sent, being mutually understood.

all periods and in all countries affected the imagination and the feelings of mankind. It is a fair inference from the universal fact, and from the concurring impressions on ourselves, that they were made to have this interesting effect, as well as to beautify our inhabited surface.* But it is not an imagination—it is a sober reality to say, that wherever they have been cherished and cultivated, they have drawn the human spirit to seek and value the gentler and kinder dispositions and occupations of our very deviable, moveable, irascible, and sturdy self-will.†

As these moral, intellectual, and religious results are the natural effects of the vegetable creation upon mankind, and appear, more or less, so much in all countries and in all ages, as to indicate that impressions of this sort are universal, we are entitled to infer that these consequences were among the purposes for which this order of beings was created, and which they were appointed to produce. The

* After describing this part of creation. Milton forcibly adds—

"Earth now
Seem'd like to heav'n; a seat where gods might dwell
Or wander with delight, and love to haunt
Her sacred shades."—B. 7. - - - -

† The connexion which the ancient Easterns felt between vegetable nature and their affectionate sympathies, we perceive in the effusions of SOLOMON, in whom even his gorgeous state could not suppress the impressions of his Flora and Pomona.

"My beloved spake, and said unto me,
Rise up, my love, my fair one, and come away.
For, lo, the winter is past, the rain is over and gone;
The flowers appear on the earth;
The time of the singing of birds is come,
And the voice of the turtle is heard in our land;
The fig-tree putteth forth her green figs,
And the vines with the tender grape give their fragrance.
Arise, my love, my fair one, and come away."
Sol. Song, ch. 2, ver. 10–13.

"Come, my beloved,
Let us go forth into the field,
Let us lodge in the villages.
Let us get up early to the vineyards;
Let us see if the vine flourish,
Whether the tender grape appear,
And the pomegranates bud forth."—*Ib.* ch. 7, ver. 11, 12.

"Awake, O north wind; and come, thou south;
Blow upon my garden, that its spices may flow out.
Let my beloved come into his garden,
And eat his pleasant fruits."—*Ib.* ch. 4, ver. 16.

general effects of all made things imply that the intention of the Maker was to produce them. So we may reason as to the design and ends of the Creator in his vegetable classes. They increase our knowledge of him; they are the pledges of his affection for his human race, and gentle attractions of our sensibilities to him; they are the great sources of our subsistence, conveniences, and improvements; they are the basis of all animal nutrition; they furnish our most constant gratifications and purest pleasures; they tend to link our kind feelings with each other, by the sympathizing admiration which their beauties excite; the cultivation they require is our most virtuous and beneficial occupation; and their serviceable properties are so arranged as to compel us to this useful cultivation, by their produce being made to arise from it. Their operation on our intellectual faculties and moral emotions is likewise that of a soothing melioration, which increases as our mind advances in its progressive civilization. All the beautiful thoughts and sentiments which poetry has breathed in every age, in praise of verdant or floral nature, and of the rural life, are the expressed homage of the heart to the charms and utilities of the vegetable creation, and are so many undesigned but implied encomiums on its invisible Author, for planning and ordaining it. Whatever we may mean, or whatever phrases we may use, we cannot commend nature without praising him. The panegyric flies immediately from the insensate beauties we may admire, to the mind which designed them and to the power which produced them. Carbon and oxygen are but the same things in the rose as they are in the gray limestone rock. It is the intellect and taste of the sublime Mechanist which has combined and arranged them, and similar brute matter, into loveliness and fragrance in the one, and left them to be in the other uninteresting shapelessness and dirty deformity.*

*Both the heart and reason feel that the poet of the SEASONS has justly as well as beautifully sung,

"These, as they change, Almighty Father! these
Are but the varied God. The rolling year
Is full of Thee. Forth in the pleasing spring
Thy beauty walks; thy tenderness and love.
Wide flush the fields: the softening air is balm:
And every sense and every heart is joy.
- - - - - - - -

The system established for the perpetuated existence of vegetation upon earth is another surprising invention of the Divine intelligence. We have now got rid of the unfounded and unphilosophical supposition of spontaneous generation. This was one of the dreams of ignorant times, when any absurdity was welcomed by some, that they might not believe in a creating power. Malpighi and Redi, and others since, have satisfactorily proved that both plants and animals arise from organized parents.* Earth produces no plant whatever, in any country, unless a seed or some vegetable germ be first deposited within it. On this point nature is constant. No law that she unfolds to our notice is more invariable than the production of her organized bodies solely from anteceding ones of the same sort. Organization only can produce organization; brute, inorganic matter never does. It never has been found to do so, and we may be sure it never can. Organization could only arise from its Creator at first skilfully combining it; and it is perpetuated by the marvellous power which he has added to it, of producing within itself new organized bodies of the same form and properties. Thus constructed and endowed, it has acted ever since, in all its appointed configurations, to fabricate within them a reproductive succession of the same kind of distinct individuals, and no other.

Thy bounty shines in autumn unconfin'd,
And spreads a common feast for all that live."

How natural to add—

"Soft roll your incense, herbs, and fruits, and flowers!
In mingled cloud to Him, whose sun exalts,
Whose breath perfumes you, and whose pencil paints."
Thomson's Hymn.

*Malpighi's important researches and reasoning, addressed to our Royal Society, from Bologna, 1681, are—on the anatomy of plants—the vegetation of seeds—of plants that grow on others—on roots and on gall nuts. He considers seeds as the eggs of plants, "e materno ovario delapsa, and requiring the fostering bosom of the great mother earth."—De. San. 14. Of this seed the plant is the fœtus.—Anat. 9. He shows the careful organizations and provisions made in nature to produce, preserve, and cherish all its vegetable offspring; and his experiments and observations fully show that it is only from such organized parents that any plant comes into existence; none by mere material accretion; and that there is a very great analogy between vegetable and animal evolution and growth, but more within the viviparous than the oviparous ova. —Anat. p. 81. His conclusion is, that a seed is an ovum containing a fœtus, which may for years be kept prolific.—P. 82.

No single organization can cause any other to issue from it than what resembles itself. The carnation never organizes a poppy in its natural course, nor the piony a tulip. Every organization, having been specifically made, is as specific in all its natural productions. Human art, by forcing on them new agencies, may compel new effects correspondent with the inserted novel causations; but these alterations only increase the demonstrations of the universal law. All new products from old organizations arise solely from introducing into these the organized materials of the novelties that issue from them. Still, whatever is organized is the child of parental organization; and every naturalist may defy all human skill to produce it from any other matter or by any other means.

But you may fairly ask, how then is vegetation found on places that are known to have originally had none, and that are not likely to have been visited by what would bring them? How, for instance, could the frozen soil of New-Shetland, amid the ice-rocks of the Antarctic, obtain the lichens, the only vegetable found, or perhaps growable, upon it? How have the coral islands of the Pacific, formed in the bosom of the waves by the petty animalculæ that construct them, derived their fine cocoanut-trees and beautiful forests? How can the new volcanic island that has just emerged from the shallow bottom of the Sicilian sea, ever acquire, as it will do, a productive vegetation?* These

* From the letters of the naval officers on the station to Admiral Hotham, in July, 1831, we learn that this volcanic island mentioned before, page 24, was first seen by Mr. Swinburne, from the Rapid, on 18th July, discharging fire and smoke. The next morning, steering towards it, he saw a small hillock, of dark colour, a few feet above the sea. It continued in a state of constant activity, discharging dust and stones, with vast volumes of steam. Within 20 yards of its western side he found a soft bottom at 18 fathoms. One mile N. from it, the depth was 130 fathoms—soft dark-brown mud. Its edge was broken down to the level of the sea on W.S.W. side for about a dozen yards. The little island seemed about 80 yards in its external diameter, and 20 feet in the highest, and 6 in the lowest part above the level of the sea. Mr. Smith of the Philomel gives its exact position as 37° 11′ N. lat. and 12° 44′ E. long. He describes it as composed almost entirely of cinders, with a sprinkling of lava, of an oblong shape, about ¾ of a mile in circumference, and, as yet, a very small base. The soundings about it were W. at ¼ mile, 72 to 76 fathoms; at 100 yards N. to N.W. 60 to 64; at 80 yards N.E. 70 to 75 fathoms; at 150 E. 62 fathoms, cinders. At the distance of 5 and 6 miles, varying from 60 to 74 and 80 fathoms, sand and small gravel. At the end of August, 1831, it was 180 feet high, and

questions are reasonable, and we can find some facts that will satisfactorily answer them.

The clouds, ever floating above us, not only bring us occasionally meteoric stones, hail, and epidemics, but also vegetable seeds, and the very lichens that would commence the new reign of vegetation on the bleak rocks of the south polar isles. A phenomenon which occurred in Persia would have had this result.* Dust and sands, heavier than many seeds, are borne by the winds and clouds for several hundred miles across the atmosphere, falling on the earth and seas as they pass along.† The cryptogamia, and many of the grassy seeds, are not more weighty than matter of this sort, which the aerial movement thus transports.‡ The sea, and its tides and currents, convey larger bodies for even thousands of miles.§ The winds carry over the seeds of large trees,‖ and disperse new vegetations with an extraordinary rapidity, and to an extent which, anterior to the ex-

more than a mile round. It is called Graham Island.....The Sandwich Islands of the Pacific have thus originated. They are all volcanic emissions.

* In the beginning of 1828, a vegetable matter fell suddenly from the sky in Persia, and covered the ground to a great extent, and in some spots five or six inches deep. Cattle, and particularly sheep, ate it; and some bread was made from it. A Russian general, who was an eye-witness of it, informed the French consul in Persia of the circumstance, who sent a specimen of it to the minister of foreign affairs at Paris. It was submitted to the inspection of M. Desfontaines, who found it to be one of those species of LICHENS which occur in much abundance. The wind must have transported it from its native place. A similar phenomenon had occurred in the same part of Persia in 1824.—M. Thenard's account to Fr. Ac. Scien. in Aug. 1828.

† Mr. Forbes, when 600 miles from the coast of Africa, found his sails covered with a brownish sand. The wind had blown all night N.E. The nearest land to the wind was the coast of Africa, between Cape Verd and the River Gambia.—Bull. Univ. 1826, p. 381. The scientific editor sensibly asks, "May not the seeds of many plants found in distant isles have been thus transported?"

‡ I have some volcanic dust that descended copiously on a ship in the Atlantic, 700 miles from the spot where the eruption was afterward ascertained to have happened. If one wind blow such things towards the sea, another would disperse them over deserts and continents.

§ Dr. Walker declared to Lord Kames—"I have found seeds, dropped accidentally into the sea in the *West Indies*, cast ashore on the *Hebrides*. The sea and rivers waft more seeds than sails."—Woodh. Life Lord K. vol. ii. p. 59.

‖ "Some, as the ash and plane, have heavy seeds, but they are supplied with wings. A gale of wind carries them from their lofty situation to a considerable distance; and they remain on the tree until this breeze comes."—Dr. Walker, *ib.*

perience, we should not have expected.* Birds also largely diffuse them. Many of these tenants of the trees and air live on fruit and berries. They digest the pulp, but pass the seeds unimpaired; and thus heavy organizations of future trees are planted in the most distant and unexpected situations.† The parasitical misseltoe, converted by the stern Druids of our British predecessors into an instrument of their governing superstition, and which they gathered, from the tree on which it fed, with such imposing solemnity, thus attains its lofty and, in the days of ignorance, mysterious situation.‡ The digestive action of the feathered race upon them improves, in some cases, instead of injuring their growing energy.§ Waves, winds, and birds fully explain the vegetations of every coral and volcanic island.‖ The amazing muscular power and vital energy of birds to sustain their flights in their migrations, for distances that astonish us, will account for the plantations of the most dis-

* "The erigeron canadense was received from Canada about 100 years ago into the Paris Garden. *It is now spread* as a wild plant over France, Holland, Germany, and Italy—even to Sicily; and to such a degree in the south of England, that it is now enumerated in the English lists of indigenous plants."—Dr. Walk. *ib.*

† "I have seen plantations of holly, yew, white beam, mountain ash, hawthorn, and juniper, on inaccessible precipices and on impending cliffs, formed by the birds, which excelled in beauty the plantations of man."—*Ib.* p. 60.

‡ "From its heavy berries, it was once thought an equivocal generation, as they must have dropped to the ground; but it was discovered that no berries are more grateful to the thrush kind; and they are by these birds dropped and planted on high and remote trees."—Dr. Walk. *ib.*

§ "Some seeds increase in their power of vegetation by passing through birds. The seeds of the magnolia from America would not grow here; but those eaten by turkeys never failed."—*Ib.* p. 61...."Hence the dung of domestic animals often fills a garden with many weeds."—*Ib.*

‖ Mr. Ellis remarks, that all the coral islands of the Pacific have an opening left in them by their indefatigable insect masons. The constant current which passes the opening probably deposited on the ends of the reef fragments of coral, sea-weed, and drift-wood, till, in time, they rose above the surface of the water. Seeds borne thither by the waves, or wafted by the winds, found a soil on which they could germinate. Decaying vegetation increased the mould; and by this process these little-fairy-looking islands were formed."—Polyn. Res. vol. ii. p. 5..... "Every year increased the substances accumulated on its surface. Vegetation at length commenced; and the process of organization and decomposition, accelerated by the humidity of the atmosphere and warmth of the climate, formed the mould in which the trees at present covering it spread their roots and find their nourishment."—*Ib.* 188.

tant isles and continents.* Even insects people inland ponds and streams with fish,† and are often themselves carried by the winds to great distances.‡ Thus showers of their larva have often fallen from the clouds.§ From all these facts, no individual of right judgment can have any difficulty of perceiving how the most remote and unvisited regions have derived their varied vegetation. We need not have recourse to the unsupported hypothesis of spontaneous production, which no circumstance that has been fully understood has at any time occurred to prove.‖ When once a vegetable has become rooted in a soil, it is capable, if un-

* The first two pigeons that flew from London to Antwerp, in July, 1830, passed one hundred and eighty-six miles in five hours and a half which was nearly thirty-four miles an hour.—Brussels Pap. July 24. Of two pigeons that, in January, 1831, flew from London to Liskeard in Cornwall, one went in six hours; the other in six and a quarter. The quails, whose wings are so small, cross the Mediterranean.....Faber saw a little wagtail in the middle of its route over the Northern Ocean, from Denmark to Iceland; and another small bird was taken in the middle of the Baltic Sea.—Brehm, in Bull. Univ. 1830, p. 140–142.

† The great river-beetle, which lives habitually on eggs of fish, climbs sometimes in the evening on the reeds high enough for its flight, and then takes wing. One was caught in its flight, and being put into water, it emitted the eggs with which it was gorged; some in part digested, and some not at all. These eggs produced fish of various sorts."—Bull. Univ. 1829, p. 145, from Gill's Tech. Rep. 1828, p. 333.

‡ "Having left Trieste, Dr. Hempuzch found the ship in the Mediterranean Sea covered with insects brought by the wind."—*Ib.* p. 53.

§ In October, 1827, in a N.W. wind, snow fell near Moscow, and with it a considerable quantity of soft blackish larvæ fell also. M. Rannett gathered several, and they lived some time in a vessel with snow. Those put in a warm place soon died; others in cold water lived very well Others of this sort were found near Zvenigerod. In the winter of 1826, some were found on the snow at Archangel, and others on a mountain near Moscow....In 1749, the ice of a lake near Sœdermanniand was covered with a great quantity of the same larvæ, which had been brought from the forests of Westermanland, where the wind had torn up several trees."—Bull. Univ. 1829, p. 310.

‖ Thus the sudden rise of mushrooms and other fungi, and their rapid growth after storms, have been deemed accidental productions; but it is found that in the process adopted by gardeners to obtain them, only one species, the agaricus campestris, ever appears; and the remark of Fries fully accounts for their descent from the atmosphere on a soil and vegetation that is fit for their growth. "Their sporules (or seminal principles) are so infinite, that I have counted above ten millions of them in a single individual; so subtile, that they are scarcely visible to the naked eye; and they are dispersed in so many ways by the attraction of the sun, by insects, wind, elasticity, adhesion, &c., that it is difficult to conceive a place from which they can be excluded."—Fries quoted by Lindsey, Nat. Syst. p. 335.....Where they fall on a proper nidus, they vegetate; elsewhere they perish.

checked, of spreading to an indefinite extent. One tree has, in some regions, propagated into a large forest.* But the possible produce which may issue from a single individual of this department of nature, like other facts that we have noticed, extends into calculations which exceed our comprehending faculty.† The just conclusion from the experience of all ages and countries is, that spontaneous production is no part of the system for the perpetuation of the vegetable races.

The REPRODUCTIVE faculty in plants exhibits a clear and close analogy to that of the animal kingdom. The artificial but convenient Linnæan system is founded upon it. One set of organs within the flower, the stamens, prepare the productive pollen, or fine dust-like substance, which passes in the proper time from them to the stigma, and adhering to that becomes the germ of the future plants.‡ Without this pollen there is no reproduction by seed or fruit. The natural pollen is the most effective,§ and no other naturally

* "Reinwardt saw, in the Isle of Semas, a large wood, of which every tree had proceeded from a single fig-tree. In Java, the first thick forest of the mountains may be called the fig-tree forest. There are one hundred species. The soil does not suffice for the plants. They lie on each other, and then grow and spread, and you search in vain for the ends of their trunks or branches."—Bull. Univ. 1830, p. 415-417.... Great branches descend from the trunks into the soil, and there take root, and shoot up into new trees.—*Ib.*

† A writer, whose name I have mislaid, has, in the instance of the elm, thus illustrated the productive power of vegetable nature:—"One of those trees has produced 1584 millions of seeds; and each of these seeds has the power of reproducing as many. At this ratio, the second generation, if every seed vegetated as prolifically, would amount to two trillions 510,056 billions. But the third descent would be 14,658 quadrillions 727,040 trillions. The seeds of this third generation from one elm would be enough to stock the surface of all the planets in the solar system, and of many more."....Such productiveness increases the inadmissibility of the spontaneous theory, by making it absolutely unnecessary. Organization has been ordained to be so prolific as to supersede the need of any other interfering cause.

‡ Mr. Knight, in examining the apple and pear, thought that the *pith* seemed to end in the stigmata; and inferred the flower to be a prolongation of the *pith*, wood, and bark. Hayne observed the cellules of the cellular tissue he calls actiniforme, to go off from the *pith* to proceed to the bark.—Bull. Univ. 1830, p. 223.

§ Gœrtner, from 600 experiments, found that strange pollen attaches less easily to the stigmata than the proper one: that the consequential enlargement is first seen on the peduncle and calyx, as the ovary does not swell until some days afterward: that the effect is the result of a slow action, and not of an immediate one, like that of electricity: that

occurs to the stigma, although pollen from other flowers may be inserted on it. We have in this operation of the motion of the pollen to its germinating receptacle, another instance of the exactitude with which the effective means have been carefully provided and adapted to their appointed ends. Although it has to pass with a precise force over the particular distance, varying in every species, that is between the stamen and the stigma, and therefore to be suited exactly to this space, and to take correctly the direction of each stigma, and this in many millions of instances at every recurring season, and to light exactly upon its minutest point; and to do this in the ever-moving air, and whatever winds may agitate it; yet this peculiar movement always takes place at the proper time in every species of plant, by a species of explosion, but with such skilful aim and measured movement, as it were, that in every plant it is performed with exact and invariable effect; so that from their creation to the present hour, every species has regularly and abundantly produced its due seed and fruit.* Wonderful has been the contrivance by which this indispensable action has been made to take place so universally and so effectually! Nothing would seem more to require an unerring eye and guiding hand, than the transfer of this little fructifying projectile from one part of the flower to that exact spot near it on which it must settle, in order to germinate into the fruit; and often from one flower to another; and not unfrequently from one plant to another. The utmost precision of the direction and degree of the protruding impulse, and the most exact timing of the discharge to the receiving state of the recipient, are in every instance indispensably necessary. The smallest error or deviation would frustrate the effect. Who is the secret calculator, measurer, impeller, regulator, and directer? Who is the floral engineer that, in each returning spring, guides and rules this botanical artillery with unfailing skill and success in the quadrillions of quadril-

the contained fluid of the pollen, combined with the fluid matter secreted by the stigmata, penetrates into the ovules, to give birth to the embryo; and that this does not pre-exist in the ovula, but becomes a product of the prolific agency.—Bull. Univ. 1829, p. 231.

* In some kinds, the flower is made to close on insects, and imprison them awhile, apparently that their efforts to escape may shake the pollen from the stamina to the stigmata, as wherever the pollen rightly attaches, it tenaciously adheres, and cannot easily be displaced.

lions of flowers that annually adorn our globe? and even, in some cases, accomplishing the prolific object at great distances.* Where the organs are on separated plants, and the end cannot be obtained by instantaneous projectility, there bees and insects are made the conveying agents, and the honey in the nectarium of flowers is the attraction that invites them to become such, though unconscious of the important purpose which they are fulfilling, while intent only on their own enjoyment.† So diversified are the means employed by the great Inventor and Preserver of our complicated fabric, to produce his appointed ends! Thus the main producing system of nature is everywhere maintained.‡ On this subject there is another remarkable congruity between plants and animals; and a further instance of the careful foresight and calculated provisions with which nature has been constructed, and its parts adapted to each other. This is, that in the number of male and female plants produced, where they are distinct individuals, the principle of equalization is observable.§

* The grains of pollen often fill the air. Treviranus saw ponds covered with the pollen of the wild pine, from a wood half a league off.—So, M. Kaulfuss adds, may the moss grains float to a part where there were no vegetables before. We every day see how rapidly a new wall or roof is covered with the gymnostomium ovatum, and grimmia lanceolata.—Bull. Univ. 1829, p. 438.

† "Sprengel has ingeniously demonstrated, by a hundred of instances, how the corolla attracts insects." "There can be no doubt that the use of the honey is to tempt insects, who, in procuring it, fertilize the flower, by disturbing the dust of the stamens, and even carrying it from the barren to the fertile blossoms."—Smith, 239, 270. M. VAUCHER thinks the honey facilitates the fecundation by dissolving the pollen.—Physiol. des Plantes Europ. (one of the latest and best works on Botanical Physiology).

‡ Henschel has recently made many experiments to see whether plants would produce if their male flowers were removed at different periods. His most satisfactory results were, that in general the female flowers did not bear fruit unless the others had not been hindered from discharging their pollen; even though the former were not then in full existence; that the most favourable period for the fertilization was uncertain, but the least favourable was before the blowing, and after its completion; that the principal stalk was more prolific than the side ones; that the age of the pollen made no difference; that the flower, deprived of its stigmata *immediately* after the fecundation, remained barren; but if not taken away until twelve hours after, the plant would bear seed.—Bull. Univ. 1829, p. 57.

§ Girou tried this on turnip and spinach. He found the proportion in those he reared to be 907 males to 1000 females, in strong plants; in their weak ones, 692 males to 1000 females. The seed from the *lower*

But although the phenomena of nature in all regions exhibit the universal presence of this floral mechanism for vegetable formation,* yet it is also certain that the reproductive system of the botanical kingdom is not confined to this mode of fructification. The living principle has also the power, in trees, of forming its offspring by buds or shoots, in addition to the flowers, or instead of them. This is a very curious fact, and has led our botanists to the perception that a tree is not a single individual, but is an actual tribe or association of families, springing from the parent trunk; closely associated with each other in collateral contiguity and compact union within one stem; yet each preserving a distinct separateness of vascularity, living principle, nutrition, growth, productivity, and subsistence. It is now inculcated, that every bud is a distinct offspring of the tree or branch from which it protrudes. When emerged into life and form, it pushes downwards its own vessels, inside of the parental bark or rind, to the earth, from which they draw a separate and proper nourishment. This they transmit to their new-born shoot; and thereby enable or assist it to expand into foliage and enlargement.† Sometimes these vessels are seen passing through the bark into

part of the ear caused more males than from the upper. Thus, from the *lower* part of their weak plants 1250 males to 1000 others, and from the same lower part of strong ones 1000 to 1000; while from the *upper* part of thin ones, the seed produced only 444 males to 1000 females; and of strong ones 827.—Bull. Univ. 1830, p. 256.

* A striking instance occurred at Abbeville, in an apple-tree forty years old, which had only exhibited imperfect flowers with styles, but without stamina. It was therefore always steril. But when at length a perfect apple-flower was plucked elsewhere in dry weather, and laid on any of the flowers and left there, the fruit always came on them, but with a contraction about one-third from the end. The others continued barren.

† Thus, in 1829, M. Poiteau stated in France his theory, that a tree is not a simple individual, as an animal is, but that it is composed of the particular productions of all its buds; and that these buds should be considered as so many seeds, which in their development produce latent roots, which descend to the earth, or tend to do so; and that the latent roots are the fibres of the wood. M. Jung, reviewing this, adds, "This is assez generalement *admise.*"—Bull. Univ. 1829, p. 75. Mr. Burnett, in England, also teaches that every bud may be considered as a distinct individual, containing, at least virtually, roots, leaves, and flowers."—Quart. Journ. Science, 1829, p. 423. "Shrubs, in general, have no buds, nor the trees of hot climates."—Smith, 136. But there are many exceptions to this.

the air, if that suffices for their nutrition.* Thus every branch, and every ramification by buds from itself, are so many new individual descendants of the general parent trunk: and the whole tree thus becomes and exists in the state of a large society, or affiliated tribe of distinct individuals, intimately associated together. Hence all trees, and some flowers, may be planted by slips or branches,† which then grow into all their functional organs, and have their principle of life as fully within them as the new-born young of any quadruped or reptile.

It appears also that plants produce either shoots or flowers, according as the circumstances under which they are at the time situated lead them to the one or to the other. After a continued production of shoots without flowers, a vegetable has, when its nutriment from neglect became insufficient for its ramifying elongation, suddenly disclosed its floral organs; and in this way prepared for an offspring by its seeds, when prevented from perpetuating itself by branches:‡ thus evincing that it had received the power of varying its mode of organic reproduction according to the immediate expediency.

This fact proves that plants have a double mode of perpetuating their species—by branching or by seed. Each is equally effectual, for every new twig is the embryo of a new tree: but it is to a seed what an animal born alive is

* Thus, "the trunk of the rhizophista at Cayenne produces roots at different heights. The fibres of the lower buds do not descend to the bottom of the tree, but become and constitute aerian roots. Nearly so the ludovia f. a plant of Guiana. Many palm-trees have their stipes sustained by aerian roots, of which the most recent are the lowest."—M. Poiteau, Bull. Univ. 1829, p. 224.

† The mulberry-tree has been raised by planting even so large a branch of it in the spring that it bore fruit in the summer of the next year. "In June, 1830, some dahlias had a few *branches* broken off by the wind. M. Jacquemin placed them in the ground, hoping to develop the leaves. This did not take place; but the plants seemed good and were found furnished with tubercles. Hence a new means to multiply them."—Lit. Gaz. 2 Ap. 1831.

‡ "The solandra grandiflora, a Jamaica shrub, was for a *number of years* cultivated in the English stoves, and propagated extensively by cuttings; each plant growing many feet in length every season, but without showing any signs of prolification. Left accidentally without water in the dry stove at Kew, the luxuriant growth of its branches was checked, and *a flower* (for the first time) came forth at the extremity of each. By a similar mode of treatment, the same effect has since been frequently produced."—Sir. J. Smith, Int. 141.

to an egg. In the one case the parent completes its offspring within itself; in the other, it prepares it ready to be afterward completed; but leaves it to undergo another process—that of hatching in the egg, and that of germination in the seed, before the new individual is perfected.

All trees display this double power, and their living principle is ever active to exert it. It does this in making continually new leaves and twigs, when it does not form flowers and fruits. It is from this action, that when it luxuriates in foliage, it forms fewer of the latter. To increase the fruit of trees, gardeners frequently prune their branches, and pluck off their leaves. This turns the producing energy from exercising itself in emerging shoots, and causes it to use its other faculty of forming flowers. Copious nourishment gives it a vigour beyond what is necessary for the floral process; and then it prefers to that its formative ramifications and leaves. Scantier food lessening its strength for this stronger action, it seeks to employ itself in the gentler and more delicate and beautiful operation of framing its corolla with the included stamens, stigmata, and pollen.*

This principle explains the phenomena of its floral organs changing into leaves, or into the corolla, or into each other, and of green leaves transmutating into those of the flower.† It is indifferent to the living principle into which of these it converts its nutrition, as either of them

* In this respect plants differ from animals. "In the latter, fulness of feeding advances productivity; but in plants, where they receive abundant nourishment, their flowers and fruit are long in appearing; but when the nourishment is feeble, and the vegetable languishes, its reproductive powers act with rapidity. The less nourishment it receives the more ready it is to reproduce."—Bull. Univ. 1830, p. 210.

† M. Candolles also thinks that they are only alterations of the foliaceous organs.—Bull. Univ. 1829, p. 231. On this curious subject, Sir J. Smith had mentioned that stigmata are often changed to the petals of the corollas in double flowers, as well as the stamens; "But," he adds, "I have met a more remarkable change in the double cherry, of the pistil (the stigma) into a real *leaf*, exactly conformable to the proper leaves of the tree, only smaller. So the garden tulip frequently has a leaf half green, half coloured in the flower. Only one instance is known of petals changing into stamens, which Dr. Withering has commemorated in the black currant; but nothing is more frequent than the alterations of stamens to petals."—Introd. Bot. 275..... He thought that the stamens and stigmata did not change into each other, but would rather turn into petals or leaves.—*Ib.*

will answer its purpose. It can by forming leaves and twigs multiply itself, as well as by flowers and seeds; and it inclines to either mode of action as superinduced exigences lead it. If it be interrupted in its elongating process, it resorts to its floral. Interfered with in this, it recurs to its foliage. It forms its stamen as one of its floral instruments; but if disturbed in this, it makes it a corolla, or a stigma; and forms a stamen at another time, or else a leaf instead. The living principle acts as if it had the choice of doing at all times either, and of always doing that which it is at the time easiest or most expedient for it to perform. Its law is to multiply. That was the original command. It has the choice of different ways, and the use of various means to obey this order, according as external circumstances may affect it; but it is continually striving to fulfil the injunction it has received, by the one process or by the other. Nothing is more marvellous—nothing can more completely illustrate and verify the creating mandate. From the moment that it was uttered, its efficiency has never ceased. There is a constant nisus in all vegetation to fulfil the ordination in every situation: and the double mode of production has been given, that, by having this alternative, no event in the ordinary course of nature may defeat it. Even mutilation of its floral organs has been found to fail in totally preventing the reproduction.*

* Henschel, doubting the sexuality, made several experiments to disprove it. In some he intercepted the pollen; in others took away the stamens, or the stigmata, and their several flowers. The results afford some curious facts of the power of the living principle to effectuate its production, though deprived of some of its natural means of doing so. His general conclusions have been mentioned in note p. 129. But he thought that in particular instances he had obtained fruits from the digitalis purpurea, polemonium cæruleum, zea mays, and ricinus communis, without pollen; also in the orchis morio, saxifraga granulata, and cucubalus viscosus, though the stigmata had faded when the pollen was emitted. The stigmata flowers were taken away from several cucurbitaceæ, except one, which did not blow till all the stamen flowers had disappeared, yet it produced fine fruit. All the stamen stalks of the cannabis sativa were plucked off before flowering, yet the stigmata bore ripe fruits.—Bull. Univ. 1829, p. 55–57.

On the whole, his mutilations so often failed, as to confirm the Linnean law, and to prove that this is the real law of nature; although when disturbed the living principle has at times the power of effectuating its appointed purpose under all the disadvantages of the disturbance.

Such experiments only show that anomalous variations or exceptions may be forced on the natural organizations. But no anomalies which are

Some natural agencies may interrupt the formative process. Frost has the fatal power of frustrating its productive agency; but this destructive effect may be averted by covering its opening blossoms.* Its germinating power is also liable to be arrested by obstructing circumstances: thus depth precludes its growth. Seeds and roots will not begin to vegetate much below the surface.† A polarization has been lately attributed to seeds in their germination;‡ and it has been ascertained that the descending radicle has the strength to penetrate into quicksilver.§

In the Linnæan class of the cryptogamia, or the natural

or violence may produce can overthrow the regular economy which has been established in each department of being. A polype may be cut in pieces, and each part may grow again, like a lobster's amputated claw, into its entirety, from the repairing or producing powers of its living principle. But nature never reproduces polypes in that way. It is not her law that polypes should be so divided, nor that the lobster should be so mutilated. Her general laws proceed steadily and constantly in their course, until violated by counteractions. Hence, all anomalous productibilities in plants neither disprove nor alter her universal modes of forming them. They enlarge our knowledge of the gifted powers of the living principle, and our admiration at the providing care with which all organizations have been made, so that even impeding interferences are prevented from defeating their assigned operations.

* Dr. Stowe wrapped the trunks of some of his chief apple-trees in hay as the flowers began to open; and though late frosts followed at the end of April and beginning of May, all these produced abundant fruit, while other trees failed.—Gard. Mag. May, 1827.

† Potatoes planted at one foot deep produced shoots at the end of spring; at two feet, not till the middle of summer; at three feet, their roots were very short, and did not come to the surface; below three feet, they never vegetated. Several were buried in a garden at 3½ feet, and after two years were found without any germination, but with their original freshness, firmness, and proper taste.—Ann. Soc. Agr. Fr. 1829.

‡ M. Poiteau's assertions are, "That a seed always polarizes itself in its germination. Its radicle becomes one of its poles, its plumula the other. That from its radicle pole a fluid issues, which seeks to put itself into relation with another fluid diffused in the earth, and by its passage draws the radicle after it, seeking to bury itself; while the opposite, or stalk pole, disengages a different fluid that puts itself into connexion with the fluid spread in the atmosphere, and raises the stem towards it up in the air."—Bull. Univ. 1829, p. 75.....It is inferred, "That these fluids are the electrical or the magnetic; and that they escape from vegetables in the same manner as from polarized metals."—P. 224.

§ Pinot communicated this fact to the Acad. des Sciences, in 1829. He had previously moistened the surface of the mercury. The seed of the latyrus odoratus was placed on it. The germination took place as usual. When the radicle reached the mercury, it pierced and buried itself in it.

one of the flowerless plants, comprising the fern-like, moss-like, and leafless vegetations, the productive organs and their seeds are so minute,—the appearances are so illusive, and the real phenomena so obscure, and by many so undiscernible,—that their mode of multiplication has not been agreed upon. While other plants are perpetuated by seeds, some of these have sporules instead, which are thought not to arise from floral organs. As these sporules are found to be real seeds, though very minute ones, they are in satisfactory harmony with the rest of the vegetable creation.* The question of their origination from the parental plant does not therefore at all disturb our views of the economy of nature. It is most probable that, as seeds, they proceed from what are analogous to the floral organs of the larger plants, and that their pettiness alone prevents this fact from being fully ascertained. Nature retires from our inquiring eye when she works in miniature; and although we can pursue her with our microscopic aggrandizers to a certain extent, yet these at last fail to make her minutenesses so distinct as to enable us to discriminate them. Their very agency sometimes creates phenomena that confuse instead of illustrating; for on such small particles the light they collect and concentrate cannot be powerless. Therefore, although some physiologists at present make a division of plants into sexual and asexual,† it is rather a temporary than a permanent distinction, at present taken for granted, but by no means definitely proved. The connected denominations of vasculares and cellulares are less theoretical, and have a more certain foundation.‡ But

* M. De Pylaie affirms, that "as these reproducing sporules have most of the conditions which attend the formation of a seed, we cannot but consider them as true seeds." He wishes to call them seminules, as marking at once their smallness and organic nature. He discerned in the fructification of some sorts a pericarpium, an integument proper for seed, and an interior mass, which can only be a simple and homogeneous embryo."—Bull. Univ. 1830, p. 290.

† Lindsey's Introd. Nat. Syst. xviii.

‡ "Plants propagated by seeds, and possessing distinct sexes, have spiral vessels." These are called vasculares. The others, supposed to be destitute of these, are termed cellulares, "answering to asexual plants."—Linds. xviii. xix. The cryptogamic class chiefly contain the latter kind; and of these, as what relates to their fructification is so minute and obscure, we may suggest that the deficiency, both of the spiral vessels and of the usual organs, may be rather of their visibility than of their existence.

as plants have the power of reproducing by shoots as well as by flowers, the fabrication of sporules without them, if that should be the verified fact, is but a production of little buds made to be separable; or else of seminal ovula by an agency analogous to the budding process. Either mode is in conformity with the general laws of vegetable nature. Among other fancies, it has been urged that confervas could unite and form themselves into moss; but such speculations have been found inconsistent with the real facts of nature, and to be disproved by them. Mosses arise from the little seeds of mosses, although they are exceedingly minute.* But all minuteness is expansible into magnitude in the magical processes of creation; and this is remarkably illustrated in the algæ kind. While some species make only a green cuticle on stones, others of the same vegetable family assume a towering size, and become what has been not unaptly termed "Forests of vegetation."† However minuteness may elude or deceive, the principle of all vegetable nature is, to originate from specific organizations in every class and kind, of some sort or other.

* M. Kaulfuss opposes the ideas of Hornschuch on the mosses. He says, "Facts resist it. M. Drummond placed, with every possible precaution, the seeds of 30 kinds of mosses on earth heated to redness, and in water. In *both* these positions the seeds germinated and *reproduced their species*." M. K. therefore thinks the theory of the metamorphosis of confervas into mosses is an erroneous deduction; and if it had been well founded, the true conclusion would have been, not a transformation, but that the confervas were only the first state of the future plant, like the eggs or larva to the future animal.—*Ib.* 438. Hedwig showed the true nature of mosses, and that they are really herbs, by raising them from their own seed.—Sir J. Smith, Int. 491. M. Ad. Brongniart also believes in the sexuality of mosses; and Mr. Brown has a similar opinion.—Linds. p. 321.

† "While the first two groups consist of microscopic objects, inhabiting obscure places, shady paths, or half-immersed surfaces of stones and banks, the more complete algæ comprehend species forming *subaqueous forests* of considerable extent in the vast ocean, emulating, in their own gigantic dimensions, the boundless element that unfolds them." Chorda filum, a species common in the North Sea, is frequently found of the length of 30 feet. In Scalpa Bay, Orkney, it forms meadows, through which a pinnace with difficulty forces its way. Lessonia fuscescens is 25 feet long, with a trunk often as thick as a man's thigh.

"But all these and every other vegetable production are exceeded in size by the prodigious fronds of macro-cystis pyrifera. This appears to be the seaweed reported by navigators to be from 500 to 1500 feet in length—yet its stem is not thicker than the finger, and the upper branches are slender as the common packthread."—Lind. Nat. Syst. p. 341. Dr. Greville's Algæ Britannicæ.

The algæ, in their simplest state, form that green appearance which we so often see on stones and walls, and in damp and dark paths and places; and in another condition, make the green matter which gradually covers a stagnant pool.* But they have also greater offices to perform. They become the first strâta of fertile soil for larger plants and trees, and cover the earth with that vegetable humus which, ever multiplying by the decay of all that grows, becomes that universal upper surface of our globe on which all orders of our botanical riches so exuberantly grow.†

The chara tribe, submersed leafless water-plants, form two genera among the most obscure of the vegetable kingdom, with regard to the nature of their reproductive mechanism, from their extreme minuteness; yet these have also been found to have a specific and constant organization.‡ They may not have flowers, but they grow and have reproducting organs to the same results, and thus appear to be true plants, with their appropriated peculiarities;§ but diminutive as they are, they are distinguished by showing, to the assisted eyesight, that ascending motion of the sap which, although certain in other vegetables, has not in them become a visible phenomenon.‖

Some observers have for a time speculated that these minute things might be animal molecules; or vegetables pass-

* Lind. Nat. Syst. p. 339.

† Algæ are most important in the economy of nature for forming the commencement of soil by their deposite and decomposition. The basin of the ocean is said to be continually rising by the deposite of such plants, particularly of conferva chthonoplastes, the closely aggregated slimy fibres of which form dense beds."—Edin. Phil. Journ. ii. p. 392. "The same circumstance occurs in lakes and ditches."—Lind. p. 342.

‡ The "characeæ are aquatic plants found in stagnant, fresh, or salt water. Their stems are regularly branched, brittle, and surrounded here and there by whorls of small branches."—Lind. 326.

§ The prolific media are the nucule and the globule in the uppermost whorls, which have been compared to the stigma and the stamen, or anther.....M. Vaucher ascertained that if the ripe nucules are kept through winter in water they will germinate in the next April.....M. Wolroth says that he has sown the globules, and they have germinated: "but this requires to be verified."—Lind. 327.

‖ Corti in 1774, Treviranus in 1817, and Amici since, have noticed this. "From all these observers it appears that if the stems of chara are examined with a good microscope, a *distinct current will be seen* to take place in every tribe of which the plant is composed, setting from the base to the apex at the rate of about two lines per minute."—Annales des Sciences, ii. p. 51. Lind. 326.

ing to the animal, or even mineral, kingdom.* But as the cryptogamic flora becomes better known to the patient examiner, these imaginations seem to be abandoned.†

Moyen once ascribed to them a mixture or succession of animal nature, from observing movements that he thought spontaneous.‡ But he has since expressly described their vegetating nature and process,§ and mentions the curious fact, that they will not germinate in the light, and therefore do not begin to vegetate until their seeds have accumulated so much together as that the upper strata of them produce an artificial darkness to those beneath them. These lower ones then immediately shoot down roots, and grow with extraordinary celerity.‖

The movements, under certain circumstances, of the little seminal particles of this low and simple order of the vegetable kingdom, have given rise to many temporary misconceptions. This is a natural result of the first perceptions of unusual phenomena. They set our inflammable imaginations on fire. We theorize before we know; and we establish prepossessions before we have collected and compared a sufficient range of facts and just inferences from them. But closer attention multiplying our knowledge and making our

* Linds. 240.

, Mr. Lindsey observes, that Dr. Greville altered his opinion of their animal nature, p. 340..... Lamoureux has now divided the algæ into six families: fucacées, floridées, dictyotées, ulvacées, alcyonides, and spongedies.—Bull. Univ. 1830, p. 459.

‡ He states, that he has seen often in the zygnema nitidum a spontaneous motion; and its filaments contract from the length of ten inches to one-third of one; and that the oscillatorias move in a circle, &c.—Agard. Spec. Alg. vol. ii. p. 48. Linds. 341.

§ "A conferva pushes its roots even into water. In the confervæ not articulated and ramified, the root is the most divided and the palest part. In those articulated and not divided, it is the last utricule prolonged into a point, which in the microscope seems furnished with ramuscules of an extreme tenuity."—Moyen in Bull. Univ. 1830, p. 255.

M. Morien's idea is, that "every sphere or little globule, independently of its neighbouring one, lives, absorbs, assimilates, grows, and reproduces on its own account."—Bull. *ib.* p. 297.

‖ "Of those confervæ which are articulated and biforcated, we shall see, if they are made to grow in a vessel, that *no root* is developed while the surface of the water is not covered by the confervas so as to produce a certain degree of obscurity. But this obscurity once existing, the plant ramifies with an incredible swiftness in the darkest parts. There is often a beginning of ramification, and then a *sudden stop* as soon as the branch *finds the light*. It is so in the polysperma glomerata."—Moyen, *ib.* 255.

reasoning more correct, our later opinions become nearer the actual truth. By this progress of our science, the belief is now declining that these motions are those of animal spontaneity; and they are referred to the agency of light, or of the varying modifications of that electricity which seems to be so universally operating in every part of nature.*

It is not unnatural that errors should arise in the endeavours to theorize on these minutiæ of nature; but erroneous hypotheses are never lasting, and need not be particularly noticed. Succeeding criticism always disperses chimerical fancies, and we may leave the fallacies to their natural mortality. These miniature organizations are not, however, beneath our notice; for they have one great value, which will always make them interesting to us. They contribute much to amplify and rectify our ideas of the Sovereign Creator, who cannot but display to us his mind in his works. He illustrates his own nature by his creations; and each part of them is a comment on the others. The whole presents a delineation of himself. Now, the marvellous immensity and multiplicity of the universe which he has made and governs present to the thoughtful mind such a tremendous Deity, that we cannot but dread lest greatness so fearfully vast should have no community of feeling with us, and should not condescend to maintain any kind relations towards us, or with the earth, our abode, which is so inconsiderable a portion of general nature. I have experienced something of this sort, and I know that others have painfully felt it. It is therefore delightful to see by these miniature existences, small almost to invisibility, and by their careful organization as finely contrived as in the grandest creature, that greatness and littleness make no difference to him in his creation or his providence. They reveal to us, that magnitude is nothing in his sight; that he is pleased to frame and to regard the small and

* Some gentlemen in France have ascribed the oscillatory, and vibratory, and circulatory motions of petty particles to a fancied spontaneous life. One of our best botanical physiologists, Mr. Brown, has judged them to be mistaken. Siedbold, who has lately written on the Japanese botany, is of similar sentiment. "He does not think that the curvilinear movements observed in the granules, on their issuing from the seeds and being placed under water, are owing to an individual vital principle. This motion is purely physical."—Bull. Univ. 1830, p. 410.

weak as benignly and as attentively as the mighty and the massive. Improved reason, indeed, makes the same deduction, because when it justly reflects, it feels that the grandest creature can be but insignificance before such an Infinite Creator. We are high and low, great and small, as to each other, but not to him. The ant is as full of life and comfort and curious instincts, and as skilfully organized, as the lion or the whale. It is therefore a marvellous property of the incomprehensible nature of our God, that he delights in all his creations. By having made some classes of organized being wondrously small, he proves in their fabrication and subsistence, to every order of nature, that no part of it has existed without his thought, nor is too petty for his notice, nor unworthy of his care. Whatever he has made that we deem as nothings in comparison with ourselves, are yet, in this view, heralds of comfort and confidence to us; for the inference becomes irresistible—indeed it has been made for us by the greatest of all authorities—that if he can make and regard such inconsiderable organizations of nature, he will never be indifferent or inattentive to us. This was the principle of that exhilarating assurance—pregnant with comfort to the humblest tenant of humanity, because unconfinable in its application,—

> "Are not two sparrows sold for a farthing? FEAR NOT: ye are of more value than many sparrows."

This sentiment, like a telescope surveying the endless expansion of space, brings the immensity of Godhead into the compass of our mental perception, and awakens within us a felicitating sensibility whenever we contemplate it.

These considerations remove the barrier of doubt and dread that would repel us from our Creator. They throw an intellectual bridge from heaven to earth, over that unfathomable chasm which separates human nature from the divine. The more largely we know the living universe that surrounds us, the more strongly we shall feel our personal inabilities: but he has descended from his stupendous ubiquity into an individualizing association of creation, government, providence, and legislation with us. We learn, as we study nature, that all must have been specially planned, and provided, and ordered to exist, because the unassisted particles of nature can no more make a hair than a head,

nor a moss or an alga, than an eye or an ear; nor ever do; we have not one fact of such a formation. Every thing organic displays the touch of Deity; and whatever has the principle of life derives it solely from him, whom the North American Indians habitually and emphatically, but with a traditional philosophy, truly characterize as "the Great Master of life."

These considerations make the creation and diffusion of the minute organizations of nature so highly interesting and important to us, when we deduce the just inferences from them. Then they are felt to demonstrate to us, as by ocular impression, that such minutenesses of attention and care are natural, usual, and pleasurable qualities of the Divine mind, notwithstanding its unbounded grandeur. Our own experience makes this deduction the more probable to us, because the greatest human minds have been distinguished by the same property; and owe their immortalizing successes to the natural power of combining the most patient and minute examination and consideration, with the most extensive plans and with their sublimest conceptions. All those whose exertions or achievements place them at the head of human fame or talent,—the Bacons, the Newtons, the Hannibals, the Napoleons, or the Wellingtons,—have been equally remarkable for these extreme and opposite polarities of intellectual nature. Vast expansibility of thought, and the most scrutinizing particularity of attention, become that surprising union of counteracting qualities which constitutes man's most aggrandized understanding. But these are only two modes of action of the transcending genius. Superior capacity will manifest its superiority in every subject to which it directs the same proportion of its activity. Grand and small make no difference to it—it uses the small to produce the great, as the Author of nature has built up his highest masses from an adequate accumulation of the smallest corpuscules.

It is therefore pleasing to see that the whole economy of nature has been formed on one universal plan, and with equal individuality of attention in every department—as well in what we undervalue as in what we most admire. In his creation, as in his government, the Creator embraces at all times, with his all-comprehending kindness, the innumerable and the unbounded—the infinitesimals, as well as

the immensities of nature—the invisible, from disappearing smallness, no less than the imperceptible, from incalculable remoteness. We may overlook what is petty, as beneath the notice of our pride; but nothing, however small, has been deemed worthless, or is disregarded by Him, whom no name or language can adequately describe; whose power is omnipotence; whose presence is universal; whose knowledge is omniscience; whose creations extend and constitute space; and whose existence is eternity.

LETTER VI.

Brief Review of the Uses of Plants in the System of Creation—Actions and Phenomena of their living Principle.

THE anterior design, the creative and contriving mind, the specific purpose, the selected means, and the appointed organization are as discernible in the USES of plants as in any other part of their wonderful economy.

That they should be the materials on which all animal life subsists, and by which it is sustained in its bodily organizations, is a well-known purpose of their formation. By the operation of their own living principle, they convert the inorganic matter which they not only find, but select out of what their roots meet, into their own kind of substance;—and this, which gives them their visible existence and beauty, becomes again transmutable into animal flesh by the animal's own vital nature and functions. This double process is every day universally going on in all the three kingdoms of nature. The word selection may seem strong; but if the radicles and the fibres of the roots entering a soil shoot towards, that which their plant needs, and though coming in contact with other particles, yet take up those only which suit them—what can we call that but selecting? There is a refusal of the one, and an active absorption of the other. A property of discerning and taking, in preference to other matter, that which is the fittest for their nourishment, seems therefore to belong to all plants.

Without vegetation, none of the animals we know, but those that live in water or air, could have continued in existence; for neither man nor animal can subsist on any thing in the mineral kingdom, until vegetation, by first making it vegetable substance, has prepared it for a future conversion into their own. Hence the justness of the Mosaic account, in placing the creation of plants before that of animals. Vegetation could have remained without animals,—but these, unless their food had been ready for them, would, under their present economy of being, have soon disappeared.*

While most of our plants thus form the sustenance and banquet of the animated kingdom, other classes of them were made and meant to be its natural medicines and secret physicians. For this purpose, those which thus benefit are universally dispersed. We may regard many of these as useless weeds, yet they silently spread amid all vegetation, to be everywhere ready for the general benefit. Brutes often need them as much as ourselves, and are repeatedly seen at particular times to select and crop the herbs that they do not use for food, but to which some recollected experience, or unexplainable perception or instinct, leads them, for their resulting efficiencies. Some of these useful plants are also so interspersed with their daily sustenance, that they cannot take the one without always digesting the

* It is interesting to read of the mutual services which the organized kingdoms from their reciprocal composition and structure can render to each other. Thus an intelligent naturalist has observed of the oak:—

"The insects which live and have their being on the oak amount to hundreds of species. It nourishes ferns, lichens, mosses, agaries, and boleti. It furnishes its apples, gallnuts, acorns, leaves, and sawdust. Some are attacked by small fungi, which break their surface, admit moisture, and facilitate decay. The leaves decomposing form a vegetable earth, and the worm seizes on them as his portion, and having fed upon part draws the remainder into the earth."

Of the ivy.—"This saves many animals from want and death in autumn and spring. In October it blooms in profusion; and its flowers become a universal banquet to the insect race. The great black fly musca grossa and its numerous tribe, with multitudes of small winged creatures, resort to them; also those beautiful animals, the latest birth of the year, the admiral and peacock butterflies. In its honey it yields a constant supply of food till the frosts of November. In spring, in the bitter months of March and April, when the wild products of the field are nearly consumed, the ivy ripens its berries, and almost entirely constitutes the food of the missel-thrush, the wood-pigeon, and other birds." —Journ. of a Naturalist, p. 66, 86.

other. But to man, plants have been in all ages the natural, and the earliest, and the most universal physicians. The metallic and mineral drugs of our modern pharmacopeias have not been above three centuries in their sanitary use. Vegetable medicines constituted the physic of our ancestors, as they still are of all nations who do not make European science their predominating guide.*

When we consider that vegetation carpets all the surface of our globe; and that its shrubs and forests still occupy the largest portion of its superficial extent;† and when we find that it is universally, by day and by night, streaming from its verdure—from every leaf, fruit, and flower—an aerial fluid of some sort or other, and in the lower region of the atmosphere, immediately over our heads, and mixing in the gaseous strata of it which we breathe;‡ we shall

* On this topic, Mr. Lindsey's Introd. to the Natural System of Botany will be found very valuable. Under the head of the Properties of Plants, he gives ample yet condensed notices of their medical uses. Decandolle's "Essai sur les Proprietes Medicales des Plantes," which he has much consulted, will be a useful companion. Mr. Lindsey deserves our thanks for so ably composing his Natural System of the Vegetable Creation. The Linnæan classification and nomenclature are very ingenious and useful; but the Natural System will always be the most philosophical.

† M. A. Moreau states, that in 1750 the woods in *France* amounted to more than *one-fourth* of the surface of the whole country. This will give us an idea of the far greater proportion of the superficies of the globe which the forests are occupying in less cultivated countries. In France they had been reduced to one-seventh when its Revolution began in 1788, and were not quite one-twelfth in 1814. In England now they are supposed not to occupy more than one twenty-third of our surface. Their quantity in the world we may reckon, from the circumstance that 2500 young trees are allotted to *every acre* in forming a successful plantation, allowing each to grow four feet apart. They seem to cover at least one-third of the earth; in some parts half; in unfrequented regions, nearly the whole.

‡ "It is agreed that in the daytime plants imbibe from the atmosphere carbonic acid gas, decompose it, absorb the carbon, and emit the oxygen. In the dark, they give out carbon and absorb oxygen, but in far less proportion."—Smith, Int. Bot. 212-213.... They appear also to decompose the moisture they receive, and to effuse the oxygen.

Some plants differ in what they exhale. M. Candolle found that some mushrooms exposed to the sun under water yielded 70 per cent. of hydrogen gas; others, in the sun, in six hours gave out 42 hydrogen and 56 nitrogen; others, in ten hours, 55 hydrogen and 44 nitrogen. In darkness this emission ceased.

It seems to be a general rule, that the green parts of vegetables are always giving out oxygen gas in light.

Gruithuisen thinks that plants have themselves produced their carbonic acid.—Bull. Univ. 1830, p. 163....The leaves and bark of the pimento exhale aromatic particles or gas so inflammable that the growers allow no fire to be made near them.

then perceive that it must be hourly causing the most important effects, additions, and changes in the air which we inhale, and must be a very essential and active agent on the vitality, functions, and powers of our material frame. The atmosphere could not be what it is, in that portion of its expanse which rests immediately on our inhabited surface, unless vegetation was around us. The powerful effects of its presence we feel in various parts, in the diseases which it occasions;* and from these we may form some notion of its extensive influence, in a minor degree, both for good and for ill, in every other locality. That it has constantly an exciting, and exhilarating, and salubrious effect, we all experience when we pass from a plantless city into a plant-abounding country. Strength and spirits arise within us as we reach the abode and diffusion of the vegetable kingdom. The eye and mind are not only animated and delighted by its beauty and quietude and gracefulness, diversified figures and colours, and by their harmless playfulness as the breeze flutters among them,—but the body feels a new vigour, and its functions new energies, by some invisible agency, of which we soon become strongly sensible; and whose gradual operation our reviving health, where it has been lapsing, so often gratefully acknowledges.

Nor does vegetation exercise a less important influence on the great pabulum of life and mind—the beauteous and indispensable LIGHT. Here again the universality of the diffusion of the botanical species attests the magnitude of the effect, to which the attention of science has not yet been sufficiently drawn. But let us consider that it has been a general law to all vegetable nature, that the colour of its leaves and blades shall be *green* all over the world. The consequence is, that for the months which elapse from the first opening of the vernal foliage, until its autumnal decline with us, half of every year, the plants and trees are absorbing all the light which falls on the surface of the earth which they occupy, and return only one-seventh part of it, and that consisting alone of one particular ray; of the seven colours or rays of light, the red, the blue, the

* These are well known in the tropical countries amid their luxuriant vegetations; and in all marshy districts; and especially in the malaria produced by moisture occurring to decayed vegetation, which is more fatal when sea and fresh water combine to overflow it.

yellow, the orange, the indigo, and the violet portions of it, six-sevenths of its whole component substance are subtracted from it, and from the air and from our respiration of it; and we have and use and imbibe only the green particles of it out of all that vegetables receive. Thus during spring and summer the green ray of light is that amid which we are peculiarly living, when beyond the atmosphere of our cities. For six months this predominates in nature: while the other and larger portion of all light that falls on plants is absorbed and buried in the vegetable mechanisms that imbibe it; from them descending through their vessels into their roots, and from these issuing into the earth, and being there disposed of in some manner which we have yet neither studied nor explored.*

In autumn, a new action in light begins; the green ray is no longer transmitted by the trees. As the principle of life withdraws from their foliage into the vessels of the branches and stem, a different process ensues. The verdant light is then absorbed instead of being reflected; and those mixtures of the other rays which constitute the brown and yellow colours of the fading leaves are emitted instead. When the leaves have all fallen, this effect ceases, and during all winter the trees absorb none of that light which their foliage thus imbibed and modified; and light must therefore have a very different action upon us at this season, compared with that which it exerts at every other. The flowers, likewise, while they are blossoming, retain and emit other portions of the rays; and the fruits in their season effect for the time being other changes also.†

* The effect of light in causing the green colour of plants is evidenced by the whiteness of those which grow in darkness. Red and white tulips are said to retain their floral colours, although so reared; but in this case, their leaves are not green, but white.—Smith, MS. Notes. "Of all greens, the most delicate and beautiful perhaps is displayed by several umbelliferous plants under our hedges in the spring."—Smith, Int. 82.

† The continual perspiration of plants is also adding increasing streams of vaporous fluids of some sort or other to the atmosphere. Hales found the great annual sunflower to perspire seventeen times as fast as the ordinary insensible perspiration of the human skin. The cornelian cherry evaporates from its leaves in twenty-four hours nearly twice the weight of the whole shrub.—Du Hamel. Phys. Arb. vol. i. p. 145.... The quantity of pores which have been ascertained in the under surface of the leaves of some vegetables is prodigious, and scarcely credible. In *one square* inch of the vine, 13,600; of the ilex, 63,600; of the common syringa and orange, 160,000.

Another very important action on the aerial fluids in our atmosphere is that which plants exert in their leaves and flowers on the electricity which appears to be everywhere about us. Spines of herbs and shrubs attract it.* All plants are found to do so.† And I have found their leaves and flowers, in some occasional experiments, remarkably susceptible of electrical agency.‡ When the pointed ends and sides and little sharp or thorny protuberances of the leaves, twigs, and stems of plants are considered, we shall be induced to infer that vegetation is everywhere producing great effects on the electricity of nature; and that this is very materially connected both with their component substance and with all their functions, growth, and secretions; not superseding the vital principle, but acting subordinately to it, and in continual co-operation with it.§

Thus every herb and tree are all day long effusing oxygen and peculiar vapour; attracting electricity; absorbing light; emitting the green ray; transmitting into the earth both the electric and luminous fluids which they have imbibed; and drawing up into themselves, from the earth, the diluted particles which respectively nourish them.‖

* "We owe to Saussure the discovery, that thorns and vegetable points attract electricity."—Bull. Univ. 1826, p. 182.... M. Aotier verified this, *ib.* 207; and Sennebier likewise.—Phil. Veg. vol. iii. p. 346.

† Bull. Univ. 1826, p. 207.

‡ On approaching a small piece of black wax, after rubbing it, to a red French poppy, laid lightly on my table, each leaf of the corolla moved to it, and waved up and down as the wax passed over it. I found the end of its stalk as moveable by it. So the small stalks of the currant fruit, laid loosely on a table, and the finer vessels of the sunflower leaf, moved readily as the excited wax came near them. In some plants, as the gooseberry, the spine is close under the bud; which leads to the inference that it attracts electricity to assist in the evolution of the new germ. In some branches it is above the bud; in others, between two buds; in others, the little twig shoots from its bud, and ends in a spine. These specimens were plucked from the common hedge-thorn.

§ "Vegetation, according to M. Pouillet's experiments, principally contributes to the electricity of the atmosphere. Hence, in winter, this must greatly differ, as vegetation is then inert."—Ferussac, Bull. Univ. 1827, p. 58.

‖ M. Martin remarks, as to the alimentary manures of plants, that they can absorb only gas or liquids, and therefore manures should be employed in these two states. Hence the use of fresh manure, as Sir H. Davy advised: he shows, from Gazzen's experiments, that the roots possess, *during the life* of the vegetable, the faculty of making soluble the substances which are very little so, and which do not in any manner dissolve themselves.—Bull. Univ. 1830, p. 215.... Pinks watered at various times with a slight solution of nitre, had a rich vegetation of leaves, and extraordinary dimensions of flowers.—*Ib.* p. 77.

These are universal effects of vegetation on the most abundant and all-pervading fluid in nature; effects which it was created to produce; and which show it to be a very important instrumentality and ever active cause, in the economy of our curiously constructed world.

But besides these uses of vegetation as food and medicine, and as powerful agencies on our atmosphere and light, it is also everywhere contributing to the comfort and convenience of man in his domestic and social life, according as his skill and diligence discover its applicable uses, and invent the means of making them advantageous to him. Hence the innumerable improvements in all the arts and manufactures which human ingenuity has appropriated, and which are daily increasing. This must be a familiar subject of observation to all. It will be sufficient here to notice only a few, as specimens of what thus abound. It is an exuberant topic, on which, your reading, or the information which you may derive from adapted conversation, will in time give you an enlarged and very gratifying knowledge.

Thus the sago palm-tree on the Orinoco supplies the Guanacas with all that they need. They live in it and upon it, with scarcely a possibility of exhausting its supplies.* The banana is as bountiful a friend to myriads of our fellow-beings in the East, both in its produce, and its power of rapid multiplication.† The Canadian birch-tree, in its mere

* "In the delta of the Orinoco they have remained for ages in these marshy districts, secured from the floods by living above them in their palm-trees. In the branches they suspend mats, which they fill with clay, and on this kindle their culinary fires. The tree gives them their food in its sago fruit. Its bark is farinaceous. Its sap abounds with sugar. Its fibrous stalks are like a pleasant fruit to eat. They yield a wine to drink, and thread for cordage and hammocks. It is curious to see a whole race living like insects, on a single palm."—Humboldt..... Its quantity of nutritive food is prodigious. "One tree in its fifteenth year furnishes 600lbs. of sago. A single acre of land will support 435 sago palms, which will produce every year 120,500lbs. of sago."—Crawfard. Ind. Arch.

† Humboldt calculates that 1000 square feet of banana plants will produce 4000lbs. of its nutritive fruit; while the same space would only grow 33lbs. of wheat and 99lbs. of potatoes. The fruit may be collected eleven months after the sucker is planted, and when the fruit is cut off, its stalk will put forth a sprout, which bears again in three months. Of the banana tribe, the gigantic leaves of some species are applied to many domestic purposes. They thatch the Indian cottages; are a natural tablecloth, and a material for basket making; and yield a most valuable

bark, is a valuable supply of conveniences to the Indian nations.* The breadfruit-tree has a bark from which the Tahitians make several varieties of their native cloth. Of the trunk they build their canoes and houses, and their articles of furniture, and extract a valuable resin; and they live upon its abundant fruit.† Their cocoanut-tree is still more serviceable for the conveniences, as well as food, which it profusely yields.‡ The hemp, flax, and cotton plants are known to all.

Enumerations of this sort might be made from all the regions of the globe; but a few more illustrations of the uses of the vegetable kingdom will here suffice. We have a familiar one in the sunflower, presented by nature;§ and a curious one, extractible from the moss-crop plant by human ingenuity.‖

Nothing is useless in vegetable nature. Even the thistles we despise and eradicate;¶ the dandelion, which we ridi-

flax, from which some of the finest India muslins are prepared. The juice of one kind is used for dying.—Linds. Nat. Syst. 270.

* Their canoes are made of this bark; and all sorts of small cups and dishes. It burns like pitch. It splits into threads; will serve for twine; and the filmy part near the outside may be written upon in pencil, making no bad substitute for paper. Stuck on a pole, it lights them while they fish of a night.—Head's Forest Scenes.

† Ellis, Polyn. vol. i. p. 357.

‡ Of its trunk, their best spears are made; the rafters, wall-plates, and pillars for their houses; their fences, and various instruments. It is also their fuel. Of its leaves they form screens, and several kinds of baskets; and plait them for bonnets. Of its fibrous part, attached to the bark, they work jackets, coats, and bags, and even shirts. Besides milk and abundant edible food, it also supplies a copious oil. The large shells of the nut, holding a quart, are used for bottles; and the smaller for cups and drinking vessels; and the fibres of its husk are made into cordage.—Ellis, 367, 372.

§ Its leaves are not unpleasing fodder to cattle; its flowers assemble the bees; and its profuse seeds are invaluable food for pigs, sheep, and poultry. A useful oil is also extractible from them.

‖ "Mr. Holliwell, near Todmeston, has manufactured a beautiful russet cloth, and also yarn for stockings, from the wool produced by the moss-crop plant found on his estate. The cloth is remarkably firm and beautiful."—New Month. Mag. Nov. 1830, p. 481.

¶ Two kinds of this plant, the milk and cotton thistle, were formerly boiled and eaten as artichokes now; its leaves as salad and greens. Its young stalks, peeled and soaked, are said to be excellent.—London Enc. 736..... Useful things have been manufactured from thistles. Goats and donkeys eat them, and in preference to other food sometimes. In Germany, after being beaten, they are given to the horses, who eat them greedily. The German cavalry have been often brought into good condition by them.

cule;* the nettle, which we dislike;† and the rush we undervalue;‡ are all convertible into beneficial uses. They have all, in some age or other, contributed to human comfort or convenience. The most intellectual of our arts, which gives to ideal beauty a visible form, is greatly indebted to botanical productions for some of those pleasing colours which imbody its conceptions. From them also many valuable dies are obtained;§ and more are yet attainable by persevering experiment. Even the vegetation of the marshes, though unfit for alimentary herbs or for habitation, becomes serviceable by the turf which it produces, and is always renewing, as it is removed, for domestic comfort.||

* The leaves of the dandelion, in early spring, afford a very good ingredient in salads. The French sometimes eat the young roots and the etiolated leaves with thin slices of bread and butter. When blanched, the leaves resemble in tint the endive. Its root is considered an equally good *substitute for coffee* as chicory.—Loud. Enc. p. 740.

† Its roots were once much used, and with advantage, in calculous complaints, scurvy, gout, and jaundice; and also as styptics. The young shoots are eaten in spring, and deemed antiscorbutic. They have been also applied to the skin for a mild blistering effect. It fattens hens. Ropes, paper, and cloth have been made of it. Joh. Francus and J. M. Dreschler have written largely on its virtues. The former recommends it as a wholesome and agreeable pot-herb; and as a good substitute for hops in preserving beer.

‡ Our common rush furnishes seats for our chairs, and pith for our candle-wicks. In Japan, it forms floor mats. At Cape Horn, the juncus grandiflorus "makes strong and lasting baskets, very solid, almost equal to Indian canes. Also, mats, brooms, and hats. It grows on the same localities as our rush. Its stalk has a very sweet taste; and when dry, resembles large hay. Its ashes are very alkaline."—Capt. Webster.

§ Several of our valuable pigments are made from various plants. Lichens furnish important dies.—Linds. 333..... Blue colour has been extracted from the straw of buckwheat. The myrtleberries of Switzerland furnish a beautiful blue die for cloth, while it also affords food to their sheep, fuel for their fires, brandy, and materials for tanning. A fine red liquor is afforded by some common plants, as the rumex sanguineus, or bloody dock, the red cabbage, and red beet, which is perpetuated by seed.—Smith, 74..... The colouring principle of the raspberry is a fine blue, turned red by the acid in the fruit.—*Ib.* 83.

|| M. Dau's valuable essay on TURF states, that the digging of this becomes more important in the north parts of Europe. It may be a substitute for coals. He divides it into four kinds. The haute marais has turf 30 feet deep; so the marais cotiers, more watery. Vegetable matter of all sorts forms the humus for its growth, or becomes incorporated with it. Dau thinks it grows 2¼ feet in a century: but in Hanover it has been long dug very regularly. The tourbieres there are 10 or 12 feet thick; they are cut to 8 feet deep, and in these eight feet, at the end of 50 years, the turf is found to form fully anew up to the anterior surface in that time. In one place, cut 30 years ago, a new bed had formed, from 4 to 6 feet. They take care to make their cuts on an inclined plane, and to keep them moist.—Bull. Univ. 1830, p. 200.

The maritime also assists some portions of mankind with food and medicine, and materials for manufacture.* The lichens likewise extend similar utilities to society;† the fungi, though deleterious when unwisely applied, yet have properties that are available to medical skill;‡ while ferns are not less auxiliary to our use and comfort.§ Such bene-

* One species of the algæ is stewed, and comes to our tables as a luxury, under the name of laver. Two others form the dulse and tangle, eaten in Scotland, which are even still, though rarely, cried in the streets of Edinburgh. Another, "the beautiful alaria esculenta, forms a part of the simple fare of the poorer classes of Ireland, Scotland, Iceland, Denmark, and the Faroe Islands. Others are valued for food in the Sandwich Islands, in the island of Ceylon, and in other parts of the East. These are for human food.

"Several species are greedily sought after by cattle in the north of Europe. One is a great favourite with sheep and goats. In some of the Scottish islands, horses, cattle, and sheep feed chiefly on another kind of it. So pigs in Gothland. While two others are part of the cattle fodder in Norway."

They furnish also medicines; a vermifuge; and the valuable iodine. One foreign species gives a glue and varnish to the Chinese, with which they varnish paper, gloss their silks and gauze, and use as we do glue and gum arabic. In Ireland, one kind is converted into size. But "it is in the manufacture of kelp, for the glassmaker and soapboiler, that the algæ take their place among the most useful vegetables."—Dr. Greville's Algæ Brit. xix. Lindsey, N. S. 342-344.

† Lichens are employed for dies, food, and medicine. They abound with oxalate of lime, or oxalic acid. The common one, on every old beech-tree, contains above 29 per cent. of it. Those on the top of fir-trees have an uncommon proportion of oxide of iron. Many are used in dying, especially two, which furnish the die so largely employed by the manufacturers, called orchall, or orseille des Canaries. The lichen sold as Iceland moss is mucilaginous and nutritive, as well as medicinal. So are other species. Some are astringents and febrifuges. The Canadian hunters often subsist on the tripe de roche; and the reindeer moss forms the winter food of that animal.—De Candolle, Essai Med. 318. Lindsey, Nat. Syst. 333.

‡ Fungi *salted* are eaten by the Russians without danger. Vinegar also takes from some their ill effects, which are often poisonous. One variety is used in the north-east part of Asia for its intoxicating effects, as wine, brandy, arrack, and opium are by other nations. It is sometimes eaten fresh in soups and sauces. Dried naturally, it is a narcotic. The Kamschatdales swallow it, rolled up as a bolus. One large or two small fungi will produce a gratifying inebriation for a whole day, especially if water be drank after it, which augments the narcotic effect. Too large a dose is spasmodic. It stimulates the nervous and muscular systems.—Linds. N. S. 337.

§ Capillaire is prepared from one of the ferns. The leaves of another is a tonic in India. Many have important medical properties, and are used as sudorifics, emetics, purgatives, anti-rheumatics, and febrifuges: others are perfumes. The roots of some are eaten for food in Nipaul and the Polynesian Islands, and elsewhere. Two kinds have been employed in the manufacture of beer; and one as a substitute for tea.—Lindsey, N. S. 314, 315.

fits and beauties have made botany an interesting study, even to nations where we least expect to find any of the paths of science either esteemed or pursued.*

These unexhausted utilities, enjoyed and derivable from all the vegetable kingdom, are another proof of the munificent philanthropy which prevailed in the creation of our globe; for they are so profusely bestowed that we now disregard a large portion of plants of important usefulness, because we have found and obtained from other countries those which we deem preferable, or have improved into a superiority. For it is another expressive indication of the foreseeing and provident benevolence of our grand Originator, that he has made the most useful trees and plants transferable from one region to another. It is from this property in them, that we now produce many of our valued trees and flowers and most gratifying luxuries of fruits and herbs. What pleases in one climate is transplanted into another, and successfully naturalized there.†

With all these facts in our recollection, let us now proceed to consider more particularly the nature and properties

* Thus we learn from Siedbold, who visited the distant East, that "in no country out of Europe is botany in such honour as in China and Japan. It has been cultivated there above a thousand years." He gives a list of ten Japanese books on botany, with *coloured figures*: one written in 1650; two in 1697; others in 1797, 1800, 1808, 1810, 1814, 1816, 1824; most at Oozaka, some at Jeddo, the others at Miaco.—Bull. Univ. 1830, p. 410.

† Thus the horse-chestnut was a native of Mount Pindus, in Arcadia.—Smith, 137.....The peach has come from Persia, where it is still in a small native state, with poisonous qualities.—Smith.....The potato originates from South America. It grows wild in Chili, and Peru, and Monte Video, in very small roots of bitter taste. The following enumeration has been made:—

Rye and wheat were first imported from Tartary and Siberia, where they are yet indigenous. Asparagus, from Asia. Cresses, from Crete. Cauliflowers, from Cyprus. Chervil, from Italy. Cabbage and lettuce, from Holland. Fennel, from the Canary Islands. Garlic, from the East. Gourds, from Astrachan. Horseradish, from China. Kidney beans, from the East Indies. Lentil, from France. Rice, from Ethiopia. Eschalot, from Siberia. Tobacco, from America. SUGAR, from India and Arabia, brought from Egypt into Sicily and Spain; by Spain planted in the Canary Islands and Madeiras; thence carried to St. Domingo, and the Brazils. Elder-tree, from Persia.

So as to the flowers: The jessamine, from the East Indies. Tulip, from Cappadocia. Daffodil, from Italy. Lily, from Syria. Tube rose, from Java and Ceylon. Carnation and pink, from Italy. I have not the author's name from whom this list was taken.—Oats are still wild in Abyssinia.

of that living principle which all vegetables appear to possess.

Plants are to the external eye inert and senseless; and yet they possess important qualities which are analogous to those that we and all sentient creatures participate. Their living, growing, feeding, reproducing, secreting, transpiring, vascular, diseased, and dying actions are universal instances of this related similitude. In these things, all that have life resemble each other, whether animal or vegetable; and however separating their other properties or capacities may be. But no stone or mineral has such qualities. These substances enlarge, but do not grow. Their enlargement is always by exterior accretion; by the successive addition of particles from without them; and never by development from within, nor by a vascular elaboration; nor by a functional chymistry, varying in each species, and producing specific products. Crystallization never performs these actions. Its agency is confined to mineral substances. The phenomena of vegetable growth invariably require life in the plant, in order to take place. We infer the action of this from its effects. What is not done without it, but which occurs everywhere when it is present, we may rationally ascribe to its peculiar operation.* Thus, as if the living principle of a plant knew its own nature, and what every part of the organic frame it animates needs, it distributes and conveys daily and hourly to its stem, its bark, wood, leaves, roots, branches, flowers, and fruits, through their several vascularities, precisely that kind and portion of the fluids it imbibes or secretes which each ought to receive. This is done with exact precision and perpetual symmetry in all, as long as no extraneous interference interrupts its operation, just as the same results are effected in all animal bodies, under the influence of their superior faculties.†

* Sir James Smith thought, that if we can obtain "in the natural world a glimpse of the immediate agency of the Deity, it is in the contemplation of this *vital principle*, which seems independent of material organization, and an impulse of his own Divine energy."—Int. Bot. p. 9.... But I would prefer, though without forgetting this original Fountain of it, to consider the vital principle as a real sui generis principle, peculiarly assigned to vegetation, and distinct from that of the animal genera, though agreeing with it in many of its qualities.

† Dr. Macculloch thus recognises this vital faculty. "There is a peculiar *sentient* principle, whatever it be, of exerting itself to repel in-

It is under the agency of this living principle, acting in its material organizations on the nutriment it imbibes, that every vegetable displays the following functions and powers:

It increases its embryo form into a larger, definite figure, by a steady gradual process, which has been noticed in the remarks on its growth.

It makes leaves and flowers for itself, of a peculiar but always constant kind and colour, unlike those of any other, and steadily proper to each species.

It forms within itself reproductive organs, appropriate to its individual nature, and to no other.

It produces by these both seeds or fruits peculiar to itself, and always resembling itself, and with the same growing and reproductive faculties.

Besides their seeds, shrubs and trees also produce resembling beings to themselves in their buds, which elongate into branches above, and descend by vessels within the parent trunk into their own separate roots below.

It receives its food from the earth, selecting what will suit it, and no other.

It imbibes such moisture, both in its leaves and roots, as it needs, and such air and light as it requires.

It elaborates these into sap, and into the other secreted fluids and fragrance, and converts them by a chymical action into different kinds of matter for its leaves, its flowers, its fruit, and other substances.*

It makes the leaves or corolla of its flowers different from the leaves of its twig, and also those of its calyx, which hold its flower, different from both the others, and always and only produces and places these different things in their proper places.

It is strongly affectible by various stimuli.†

jury. A plant attempts, by *its own efforts*, to naturalize itself to a new situation or worse climate. It attempts to become hardier; and it does become hardier."—Quart. J. Science, No. 10, p. 226, 227.

* "When we attempt to consider how the particular secretions of different species and tribes of plants are formed; how the same soil, the same atmosphere, should in a leaf of the vine or sorrel produce a wholesome acid; and in that of a spurge or manchineel a most virulent poison; how sweet and nutritious herbage should grow among the acrid crowfoot and aconite; we find ourselves unable to comprehend the existence of such wonderful powers in so small and simple an organ as the leaf of a plant. The agency of the VITAL PRINCIPLE alone can account for these wonders."—Sir J. Smith, Intr. p. 217

† Sir J. Smith, in his Lectures, in 1794, stated, "We cannot doubt that

Accomplishing all these actions, the living principle remains with all these powers in its organized frame during the period that has been prescribed to it; and leaves its temporary abode and all animal life when that period has been fulfilled. Beyond this departure we cannot trace it. The plant is forsaken by it, and dissolves into its material atoms; but the principle of life was not these, and therefore must be disposed of, distinct from them, according to those laws which the Creator appointed to attend its earthly death, when he first fixed the laws and place of its living existence.

Besides these general actions, particular plants exert particular agencies. The stamina of the common barberry always contract if an insect or strange body touch them.* In dry soils, plants invariably shoot out towards those parts from which they can derive the most nourishment.† "Cucumbers and melons stretch out in long branches. If any of these, in shooting out, approach near a stone, they do not go on and touch it, but they *stop short* before they reach it, and then spread themselves round it."‡ This so much resembles instinct, perception, will, and judgment, that it compels our reflection, and ought to induce some careful experiments to ascertain the nature of the phenomenon.§

plants have a living principle capable of being acted on by stimuli. They receive and search out from various substances their proper food, which favours their development. The analogy between them and animals is great in this respect. Whatever they imbibe beyond the quantity necessary for nutrition they exhale by perspiration, just as animals in that way throw off their superfluities. Like animals, they have their secretions, which appear in gums and many products, which are more curious than the animal secretions."—MS. Notes.

*M. Göppert found that prussic acid, alcohol, and ethers, and the metallic salts, destroyed, more or less rapidly, this irritability of the stamina; but that the narcotic poisons had not this effect.—Bull. Univ. 1830, p. 264.

† Sir J. Smith, MS. Note.—"The roots of trees and plants wander up and down, *seeking* for sustenance. We frequently see them growing on rocks, extending their roots, like sensitive beings, searching for moisture."—Knap's Journal of a Naturalist, p. 380.

‡ Smith, MS. Notes.

§ Sir James added, "Here it is said, the plant shows a power of perceiving that the stone is near it, and of shunning it. But the truth is, these plants shoot towards the light, and are always in search of that and of heat. A stone intercepts these, and occasions a want of them in the parts very near it. These plants feel this want, and therefore go round where they can have both."—MS. *Ib.* . . . . But, with deference to Sir James, this explanation does not remove the difficulty; for it still

The mimosas, and other sensitive plants, have that exquisite susceptibility, that delicate moveability, that an impression made in the most gentle manner on one of their leaflets is communicated in succession to all of them.* Spontaneous movements appear in another of this tribe, independent of any external stimulus, even of light, and only requiring a very warm, still atmosphere, to be performed in perfection.† A great number of leaves follow the sun in its course.‡ The stately annual sunflower, after following the sun all day, returns after sunset to the east.§ The daisy and the tulip close and open their flowers every evening and morning.‖ The motivity of the vital principle under the influence of heat is perceivable in many common plants.¶ The nightly

leaves to the plant the faculty of searching for light and heat, and of feeling the want of them, and of discerning what was the best thing to do to regain the possession of them, and of doing that best thing accordingly. Thus, though it does not perceive that a stone is near it, yet it feels that it is coming where there is no light and heat; it avoids, as if from its choice and will, going into such a place, and it forces its growing fibres out of their straight and natural direction, into an unnatural bend, that must require much exertion to take, and it forms its future growth according to this necessity. Neither animal nor man could, in such a case, do more. Human judgment could add nothing, if in the plant, to what the plant, without our intellect, quietly performs.

* "It is in vain to attempt any mechanical solution of this phenomenon."—Smith, 211. . . . . Nor will electrical agencies satisfactorily explain it.

† "The hedysarum girans:—Each leaf is ternate; and the small lateral leaflets are frequently moving up and down, either equably or by jerks, without any uniformity or co-operation among themselves. It is difficult to guess at the purpose which this singular action is designed to answer to the plant itself."—Smith, p. 211.

‡ "A clover-field is a familiar instance of this."—Smith, 210.

§ "The nymphæa alba is truly described by Linnæus in his Flora Suecica, as closing its flowers in the afternoon, and laying them down on the surface of the water till morning, when it raises and expands them often, in a bright day, several inches above the water. I can speak to this from my own knowledge."—Sir J. Smith, p. 333.

‖ The daisy commonly folds up its floral leaves as the sun sets; but I have seen it repeatedly close before the sun was down. It usually waits for his presence before it opens: if the day be cold, it remains closed, notwithstanding the light. These motions imply something like animal joints and fibres.

¶ In his lectures, Sir J. Smith stated—"Plants highly sensitive to light are those of the leguminous or pea kind. They always close up in the evening, and clasp their two upper surfaces together, presenting only their backs to the air. Plants of pinnated leaves, as the tansy, are more sensible than these to the effects of light. They fold up when light is *too strong*; as in the robinia, it produces the same effect as the want of light. Its leaves close up apparently because they are receiving

closing of their leaves is called by Linnæus the sleep of plants.* This phenomenon is another analogy to the animal nature, which is increased by its accompanying more strongly and prevalently the youthful period of the plant; as young animals, like childhood, require more slumbering rest than mature life.† It is not a less remarkable exertion of this faculty, that the leaves of the flowers often close in rain, to keep their producing organs from being injured by it.‡ Other phenomena evince actions of the living principle, for which no material cause at the time is perceptible.§

From all these facts we infer, that plants have been

too much. So they do if a hot iron be brought near them. They contract, as if to avoid the heat. Sensitive plants, and those of the oxalis lent, are so sensitive, that the least motion, even a breath of air, will make them close."—MS. Notes.

* "He has written a dissertation upon it in his Amœnitates Acad. which is very curious, as all his physiological dissertations are."—*Ib.* MS.

† "It appears that this folding up arises from the cessation of the constraint in which light keeps them. This may be as useful to them as rest to animals. So young plants require more sleep than the older.—Old leaves are almost insensible in this respect, and do not close. So when plants possess any irritability, it is more evident in the young than in the aged ones. In those plants which have a serpentine motion, this is most visible in the young ones. The old scarcely show it."—*Ib.* MS.

‡ "To a circumstance of this kind Linnæus was first indebted for his discovery of the sleep of plants. He had a new species of lotus, and being pleased with seeing its red flowers, he went one night to have the gratification to look at them, and was much concerned to see that all the flowers were gone. His admired beauties had disappeared. Returning to it the next day, he was astonished to behold them again, just as before. He then found that the leaves, by closing at night, had completely hidden the flowers."—Sir J. Smith's MS. Notes.

§ Malpighi affirms that he saw a spontaneous motion in the spiral vessels of a plant. His accuracy of observation and statement entitle this to be remembered, though others have not noticed it. Mr. Knight shows that plants *acquire habits* with regard to heat, which prove their vitality.—Phil. Trans. 1801, p. 343. "A *forced* peach-tree will, in the following season, expand its buds prematurely in the open air, so as to expose them to inevitable destruction."—Smith, 91.

Some plants actually generate heat in themselves, like animals. Lamarck states, that in the common arum maculatum, the flower, at a certain period of its growth, is for a few hours so hot as to seem burning. Flore Franc. iii. p. 538. Senncbier discovered that the heat began when the sheath was about to open; and was perceptible for eight hours, from the afternoon to midnight. It was seven degrees of Reaumur's scale *above the heat* of the air."—Smith, 92. . . . . "The powder in the theca of the club-moss tribe is highly inflammable, and employed in the manufacture of fireworks."—Linds. Nat. Syst. 317.

created on the system of having a living principle within them, capable of producing these various results. This principle is not their material organization, because this, when they die, like the animal body on a sudden death, subsists in all its completeness at that moment, and yet it can no longer perform any of the functions of its life. It is also something different from heat, light, and electricity, which can act upon its frame while it abides there, because neither of these aerial fluids can supply its place or do its offices after its departure. It is distinguished from its own and from all inorganic matter by its peculiar power, which life possesses in both plants and animals, of counteracting the laws of chymical affinity while it is in the organic frame, although these begin to operate irresistibly as soon as it has retired.*

Vegetable life resembles nothing known in nature but animal life, and with this it has a striking analogy. Many of their functional operations we have noticed to be alike; and these, in both, require the presence and co-operation of their living principle, and cease in both when that is withdrawn.

Its presence and activity first appear in the germination of the seed or bud, as they do in the animal egg under the warmth of incubation. In plants germination seems to have a specific and regular term of germination in each particular species.† But though cold represses it, yet this repression only causes it in the regions of frost and snow to spring up, as soon as the brief season of heat occurs, with

* Humboldt remarked this law, by which no vegetable suffers putrefaction or decomposition in any part until its living principle has retired from it: then a leaf changes, and a flower decays, and a branch withers, but not till life has left that part.

† Adamson has given this table of the periods in which the following seeds germinate after being sown:—

Wheat; millet	1 day.	Purslain	9 days.
Spinach; beans; mustard	3 days.	Cabbage	10 —
Lettuce; aniseed	4 —	Hyssop	30 —
Melon; cucumber; cress	5 —	Parsley	40 or 50 —
Radish; beetroot	6 —	Almond; chestnut; peach	1 year.
Barley	7 —	Rose; hawthorn; filbert,	2 years.

By steeping the seed in the chlorine gas, the process was hastened: cress-seed then began its germination in 32 hours. Achard found that they would not grow in heterogeneous hydrogen gas.—Loud. Enc. 195.

a rapidity which the temperate climates do not experience.* It can lie dormant without expiring in some species, when it seemed to have forsaken them.†

This living principle has the singular property of remaining dormant and inert for years or ages, without therefore ceasing to exist. We all know that seeds may be kept a long while unsown, and yet grow whenever planted in a suited soil. This, again, is like animals who have been found enclosed in trees, and yet have revived. When plants are buried in the ground to a greater depth than is natural to them for their proper growth, they do not vegetate; but they do not therefore die: they retain their power of vegetation to an unlimited period; and when, by any accident, brought so near the surface as to suit their evolution, they begin immediately to grow.‡ Ground that has not been disturbed for some hundred years, on being ploughed or turned up for any considerable depth, has frequently surprised the cultivator by the appearance of plants which he never sowed,§ and often which were then unknown to the country. This has arisen from ancient seeds becoming deeply covered, and there remaining inert, but yet retaining their principle of life. This principle has been ascertained to be capable of existing in this latent state for above two thousand years unextinguished, and springing again into

* A Lapland and Siberian yew exhibits remarkably rapid vegetation, beginning and fruiting in a single month; thus—

July 1.—Snow gone.
9.—Fields quite green.
17.—Plants at full growth.
25.—Ditto in flower
Aug. 2.—Fruit ripe.
18.—Snow.

And from that time snow and ice to the 23d of June, when they begin to melt.

† Thus mosses "Are extremely tenacious of life; and *after being long dried*, easily recover their health and vigour by moisture. Their beautiful structure cannot be too much admired."—Sir J. Smith, Intr. 493.

‡ "If the ground in old established botanic gardens be dug much deeper than ordinary, it frequently happens that species which have been long lost are recovered, from their seeds being latent in the soil."—*Ib.* 94.

§ "A field that was thus ploughed up near Dunkeld, after a period of forty years' rest, yielded a considerable blade of black oats without sowing. It could have been only from the plough's bringing up to the surface seeds that had been formerly too deeply lodged for germination."—Loud. Encyc. Gard. 194.

active vegetation as soon as planted in a congenial soil.* It even remains unimpaired in blighted corn, and will grow from that as vigorously as from the perfect seed.† But yet, although thus abiding in vitality in its dormant state for an indefinite length of time, such is its delicacy of existence when once roused into its living action, that it perishes for ever if it be prevented from continuing its growth.‡

This living principle can subsist in all its reproductive power in fruit-trees from one to two centuries,§ and in others for many more.‖ Some of the poisons affect the activity of this principle, though they do not destroy it.¶

But although we can observe these effects, we do not know what vegetable life really is. We can discern it to be something distinct and different from all the known material agencies of nature. These can excite and affect and assist the agency, but cannot without it do what it does, nor be what it is. We are therefore authorized to deem it a peculiar sui generis principle, as distinct in plants from their material laws and substance as life and instinct are in animals.

It is affectible or can be influenced by light, in its stem, leaf, and flower. It turns to this the upper surface of its leaves, and if they be forcibly turned from it they will

* At the Royal Institution in 1830, Mr. Houlton produced a bulbous root, which had been discovered in the hand of an Egyptian mummy, where it had remained above two thousand years. On exposure to the atmosphere it germinated, and when planted in earth it grew with great rapidity.—Jour. Roy. Instit. No. 1.

† Sir Joseph Banks, in 1805, sowed eighty grains of the most blighted wheat in pots, in a hot-house, and had seventy-two healthful plants.

‡ "Those who convey seeds from distant countries should be instructed to keep them dry; for if they receive any damp, sufficient to cause an attempt at vegetation, they then necessarily die, because the process, as they are situated, cannot go on."—Smith's Introd. 99.

§ An apricot-tree one hundred and twenty years old, was bearing fruit sufficient for any family.—Life of L. Kames, vol. ii. p. 73. Pear-trees planted in the time of King William were, by gradual paring away the old wood and bark, covering the garden walls with new branches and fine fruit in 1807.—Smith, Intr. p. 29.

‖ A yew-tree was in existence at Peronne, in Picardy, in 1790, which was mentioned in the original charter for building the church in 634.—Journ. of Science, No. 40, p. 412. ... The most vital parts of the stem of a tree are thought to be the innermost layers of the bark, and the outermost layers of the wood.—Quart. Journ. Agric.

¶ Thus sensitive plants lose their power of contracting, if laurel-water, opium, or nux vomica be applied. So they contract from camphor, and do not dilate again.—Quart. Journ. Science, vol. ix. p. 203.

gradually revert back. Heat alone will not produce this effect.* Many close their flowers, and others droop their leaves, when the light departs, as if to take their sleep;† and expand them in the morning, at various hours, according to their species.‡ But this does not depend upon the sun; it is more like the roosting of fowls.§ Some flowers follow the path of the sun. The ripe ears of corn, in a whole field, will be found during the daylight to incline to the south, though they return to a different position at night. Warmth has a perceptible effect in raising the principle of life to its germinating and floral action. Hence a mild winter will cause it to anticipate its vernal efflorescence. Some plants also discover a peculiar susceptibility of atmospherical agencies, probably to electrical influences, which science has not yet elucidated.‖ The motions of the moving plants are as yet not at all accounted for.¶

* Bonnet placed some plants in a heated stove; yet the stems did not incline to the side of the greatest heat, but to a small opening of the stove, from which some rays from the burning fluid issued.....Sir J. Smith, in his lectures, stated, "It is an invariable circumstance, that plants always turn their stem and leaves to the light, not towards the air. If in a hot-house, the door of which is left open, we shall yet always find them inclining to that side where the light is, let the air come in whence it may."—MS. Note.

† This may be seen in the daisy and the convolvulus. The leaflets of the mimosa fold themselves up along their common foot-stalk. Pliny and Theophrastus mention the lotus of the Euphrates as sinking below the water at night, to rise above it, and expand its blossom as the sun returns.—Smith, p. 333, 334.

‡ Flowers of plants removed from a hotter to a colder climate disclose their flowers at a later hour. Thus, that which opens in Senegal at six will not unfold in France and England till eight or nine, and in Sweden not till ten; and the flower that does not open in Africa till noon, or later, will not open in England at all.

§ The convolvulus minor in our garden folded up its corolla in August at four in the afternoon, though the sun did not set till near eight. It opened in the morning gradually about two hours after the sun had risen.

‖ If the Siberian sowthistle shuts at night, the ensuing day will be fine: if it opens, it will be cloudy and rainy. If the African marigold continues shut after seven in the morning, rain is at hand. The convolvulus arvensis, calendula fluvialis, and the anagallis arvensis, or poor man's weather-glass, close on the approach of rain.—L. Enc. 231.

¶ Mohl gives the anatomy of the sarmentaceous plants, and says, "Most of them turn to the left, and this direction is not owing to the action of light, or to the appui. This motion of the vrilles does not arise from spiral vessels, but from the irritability of their cellular tissue. In their revolving, the vrilles turn equally every way. But the stigma only move from below upwards, and always in one determinate way."—Bull. Univ. 1830, p. 261.

It is also one of the laws on which the vegetable organization has been constructed, that its living principle shall be separable from it, and shall depart from it, just as in man and brute. Here again specific ordainment visibly appears. Each has its appointed period of duration peculiar to its species, and dies when that has been reached. Thus, some are only annuals, and do not survive the year; others are biennials, or grow up in one year and die in the next; while others are perennials, or last for many years, reviving every spring. The changes which take place on the substance of the firmest tree, when its living principle has left it, attest the reality and power of this energetic agent, which, while it abides in its organization, resists and prevents such a material dissolution.*

LETTER VII.

The local Creation and gradual Diffusion of Plants—The fossil Traces and Remains of ancient Plants in the subterranean Strata—Their Indications of the primeval State and Vegetation of the Earth.

When the command was issued for the vegetable kingdom to arise, the whole of its numerous races either appeared simultaneously in every part of the globe, in immediate diffusion and completion; or they emerged on such particular portions only of the surface as sufficed for the production of every species; and from these primitive localities were disseminated gradually and successively over the rest of the earth. The sacred record does not decide or elucidate this point. It has preserved the man-

* "When life is extinguished, nature hastens the decomposition. The surface of the tree is overrun with lichens and mosses, which attract and retain the moisture; the empty pores imbibe it; and putrefaction follows. The tribes of fungi which flourish on decaying wood then accelerate its corruption. Beetles and caterpillars take up their abode under the bark, and bore innumerable holes in the substance. Woodpeckers, in search of insects, pierce it more deeply, and excavate large hollows, in which they place their nests. Frost, rain, and heat assist, till the whole mass crumbles away, and dissolves into a rich mould."—Convers. on Botany, p. 365.

date for their general creation, and declared its fulfilment, but has not described the manner or the extent of the first formation. Satisfied with asserting that all plants were the special and appointed creation of the same God who made the rest of our globe and the starry orbs which surround us, it leaves the chronology of every local vegetation to be investigated and ascertained by human inquiry and patient consideration.

If we consult our historical and geographical communications on this subject, we find that the vegetation of many countries which have been examined, and of all newly-formed islands that have lately arisen, has been, and still continues to be, a progressive process; and we may trace it ourselves on many places near our domestic residence. We see the lichen class arise as their minute seeds descend; and decay and reappear from new germinal matter, till they have formed enough of vegetable substance for the sporules of the mosses, which at their seasons of fructification float extensively in the atmosphere, to fix on and to grow from. These mosses in like manner vegetate and decay, and on their decayed remains a new vegetation of the same sort springs up, in like manner to die and become a thicker mould for the passing seeds of other plants to find sufficient for their germination.* Every year thus produces a new bed of vegetable matter, which is frequented by the seeds of new plants, and, in time, of trees, as those various causes which we have in a preceding Letter enumerated bring them to the spot.† Thus, in the course of a few years, every new coral island that is made by its petty architects, and every volcanic one that arises in the sea, become, in no long time, covered with plants and trees.‡

* This process may be noticed on roofs, and in part on palings, only the latter being perpendicular, the new seeds do not sufficiently fasten on them, but drop off to the ground. It may be seen more clearly on inclined tiling; and partly on the common roofs. There, if the experiment be made, and be patiently watched for a few years, the progression will be distinctly seen. I have found mosses arise upon the decaying lichens, and new mosses, of a thicker foliage, grow upon the dead matter of the former ones; and the grasses afterward appear, as soon as the decayed remains had become a sufficient soil for their germination.

† See before, p. 123–126.

‡ See before, p. 123, Note[*].—M. Bennett, who has described his recent visit to several Polynesian islands, has thus noticed this process in

As vegetation has thus disseminated itself in our own experience from country to country, and still continues to do so from places where it abounds to every new surface in which it is deficient, it seems to be a reasonable presumption, that at the epoch of its creation some similar system was adopted for its diffusion. In the appointed spot, in the Garden of Eden and in its vicinity, on the suited soils, all the families of the botanical kingdom may have simultaneously appeared as soon as the order for their production was expressed. All the previous preparations having been made, they would emerge simultaneously to the command. One large district, or island, with mountain, hill, marsh, heath, and valley, would have been quite sufficient for the primeval evolution of a sufficient number of every species. In this space, with those differences in the nature and elevation of the surface, all the known classes of vegetation might germinate and grow. Such a region appears now in one single island within the torrid zone, where both the alpine and the equatorial herbs and trees have been observed and discriminated by the scientific botanist.*

one of the Caroline group: "A small low island, a mile and a half in circumference, it is covered with cocoanut-trees, in various stages of growth, with other trees and shrubs. This island may be considered as the SECOND stage of the formation of a coral island. The minute zoophytes first cause the coral to rise above the surface of the ocean, and to form a barrier which resists the fury of the waves. On this sand gradually collects; and the reef becomes the resort of aquatic birds. A mould gradually collects from the dung of birds, and from the decomposition of vegetables or animals, which may by chance be thrown on it. Then a cocoanut (its rough outer coat protecting the germ, and rendering it impervious to the salt-water), borne by the current from another island, is thrown on the beach, where, exposed to the sea air, it vegetates and propagates its species. This is so prolific, that one fruit-bearing tree would soon cover an island. Other seeds also, rendered impervious to the water by their dense coats, are borne by the current. Birds, or casual visiters, may add others; and thus in the course of time a VERDANT island is produced."—Un. Serv. Journ. Oct. 1831.

* Humboldt had remarked, that there is now upon the earth a geographical distribution of plants, according to its various climates, which he distinguishes into so many zones of vegetation, from the frozen pole to the equator. When he visited the mountainous island of Teneriffe, he perceived that its various heights, which, as in all mountains, are colder as the elevation increases, exhibited corresponding differences both of plants and temperature, which he divided into five zones, each clearly marked by their respective vegetations. This fact shows, that at their primeval creation, one district on the earth that was warm enough at its surface, and had mountains which rose high enough to

From such an originating region as this, the various plants, if left to the operation of their respective qualities, and of the natural agencies, which in the established course of things are gradually acting upon them, would be progressively disseminated into every other country, according as its various localities should be adapted to receive them. Few, if any, plants are strictly confined to any one zone or latitude on the earth. All may grow everywhere,* although in some soils and climates they will spread more numerously and grow more luxuriantly than elsewhere.† It has been observed of the rocky places, where only the lower and smaller classes of vegetable nature can subsist, that the seminal particles do not settle and spring up from some, but yet will evolve in others. But each, as it floats along the ever-moving breeze, selects, as it were, its own suited bed of nutrition, and there unfolds its efflorescence

have a polar climate at their summit, was capable of containing all the diversities of vegetation that we know of. Humboldt thus distinguished the plants at the different heights of Teneriffe :—

I. The zone of *vines*, which extends to 1500 feet above the level of the sea.

Here are many tropical productions,—the *date*-tree, the *plantain*, the *sugar*-cane, the Indian *fig*, the *clove*-tree, mingled with the fruit-trees of Europe.

Here also the culture of the *bread*-fruit trees of Otaheite, the *cinnamon*-tree of the Moluccas, the *coffee*-tree of Arabia, and the *cocoa*-tree of the Pacific, has been tried with success.

II. The zone of *laurels* embraces the woody parts of the island.

Oaks, chestnuts, with a great number of beautiful *evergreens*, crown the hills which lead to the *volcano*.

III. At 5500 feet above the sea is that zone which is occupied by a vast forest of *pines*.

IV. and V. are covered with *alpine broom*, and herbaceous plants, occupying heights equal to the most inaccessible summits of the Pyrenees.—Hist. Marit. Discov. vol. iii. p. 250.

* The result of Humboldt's inquiries as to the geographical distribution of the monocotyledons implies this fact; for he reckons that they form one-sixth of the flowering plants in the equinoctial regions; one-fourth of those in the temperate zone; and nearly one-third towards the polar circle. Thus they are in all climates, but in different proportions in each.

† Thus, according to one enumeration, Italy is poor in cryptogamias, but is the country of leguminous plants; as England is of mosses; and Scandinavia of lichens. The rushes, grasses, and cyperaceæ abound in North Germany and Holland; the labiatæ and corymbiferæ, in France and Spain; and the ranunculaceæ, pedicularæ, saxifragæ, and cruciferæ, in Savoy and Switzerland.—Bull. Univ. 1829, p. 421.....All these countries have some of each; but the different classes flourish more abundantly in some regions than in the others.

and produces its successor.* Aqueous plants would in like manner arise, as their seeds were wafted to watery places. And in this way vegetation may have originally spread from the district where it was flourishing, to those which it had not before reached. This progressive diffusion would journey far beyond the disseminating process of animals or man, and would so far precede them, that long before they could extend their dispersing colonies around, the earth would be everywhere abundantly clothed with all that either could require. We infer that this was the primitive mode in which vegetation was spread over the earth, because we know that the largest portion of the herbs and trees which any nation now possesses has been thus successively introduced. We can trace the chronology, and date the origin, of no small part of our own insular vegetation; as we can of several of our fish and animals. From what we know to have thus taken place in the later ages of the world, we reason up to what most probably occurred in its primordial times. In this diffusing process, the most diffusible would be the first, and the most universally diffused; and this truth explains the fact, why the cryptogamiæ are in many places, both antediluvian as well as postdiluvian, found to have been the original vegetation.

As far as we can reason from existing phenomena, it would appear that vegetables do not grow upon any thing but vegetable matter, except the simplest cryptogamias, which begin the curious process on bare rocks or mineral earth, and, by their decay, provide the first nutritive mould on which other seeds germinate. All plants have the property of adding to their organization carbonaceous matter. Whether they make it by some unknown process of their living principle, or separate it from the atmosphere, it is

*In M. de Brebisson's Memoir on the Vegetation of Lower Normandy, it is remarked, that the mineralogical nature of the soil exercises an influence on the geographical distribution of plants. The cryptogamias particularly appear to prefer individual species of rocks. In the secondary formations he observed a number of plants that were never found in the more ancient earths. It is generally believed that the number of the algæ is less considerable in the secondary rocks than in the anterior ones. The thalassiophytes floridées seem to have preferred the calcarious ones; while the fucacées abound on the submerged granite of the latent ones.—Ferussac. Bull. Univ. 1829, p. 54

certain that their substance while they live, and their remains when they die, largely contain it. Thus every decayed vegetable leaves a carbonaceous mould for the nutrition and growth of new ones.*

It is the appointed nature of lichens to evolve their vegetation without a previous vegetable soil; and thus to commence the formation and deposite of the particles of carbon, which are the food that all roots seek and imbibe;† but all plants, excepting those which can thus grow on the bare mineral rock, require a provided bed of vegetable matter for their seeds to grow in, which is by this process gradually obtained. The whole surface of the earth, that is not a sandy desert or a denuded rock of stone, has by these means become covered with layers of vegetable matter, in the successive additions of nearly 6000 years. Every spring a new growth of plants, in their various classes, arises around us, and decays every autumn. Their annual remains then falling and decomposing, mingle with the earth they sprouted from, and thereby increase its power of nourishing new ones. The warmer the climate, the less need appears for the simpler ones to precede, if there be aerial carbon or matter enough to give them the nutrition they require.‡ But in all regions, the mosses, grasses, herbs, and leaves, and decomposing bark and wood, have been every season laying their decompounded matter in successive strata on the general soil, till earth has become strewed with the vegetable ruins and riches of almost sixty centuries. In proportion as this accumulation has increased,

* Saussure conceived that his experiments proved that plants, during their growth, acquire an additional quantity of carbon.—Rech. p. 50-53. "The conjoined evidence of the experiments of Braconnot, Shrader, and Embof seems to prove very clearly that we cannot account for the introduction of the constituents of vegetables from the soil or water with which they are in contact."—Bostock's Phys. vol. ii. p. 388.

† Pulverulent lichens are the first plants that clothe the bare rocks of newly-formed islands in the midst of the ocean. Foliaceous lichens follow these, and then mosses and hepaticæ. The same species seem to be found in many different parts of the world. Thus the lichens of North America differ little from those of Europe.—Linds. N. S. 333. Two of the hepaticæ were found in Melville Island, in the north polar ocean.

‡ Humboldt remarks,—"It is not in general by mosses and lichens that vegetation begins in the countries near the tropics. In the Canary Islands, as well as in Guinea and in the rocky coasts of Peru, the first vegetables that prepare the mould for others are the succulent plants."—Humboldt's Geog. des Plantes.

the soil of every country has become more fertile; and this fact strengthens the supposition, that the vegetation of every country has progressively advanced in the multiplicity of its species, according as its organic mould became thus every year more and more enlarged and fitted to receive and nurture the more important plants. Only plants with short roots can grow on a scanty soil. Its quantity of vegetable mould must be augmented, before trees with deeper roots can largely grow, or permanently abide. They will germinate on almost any portion of such matter, but soon perish if the earth be not sufficient for their increasing development. Hence it appears most probable that the first miraculous production of vegetation was limited to such a locality as would admit of all its species to appear; and that from this commencing nursery, it was gradually disseminated from region to region, according to the laws and qualities of each individual species. The simpler cryptogamias, the lichens and mosses, would diffuse themselves on the barren rocks and mineral surface, to begin the first layers of carbonaceous matter. The simple fern tribes would find in this sufficient nourishment for their evolution. Their remains would enable the floating seeds of the grasses to find a congenial bed for their rapid growth; and their decay would so enrich the organic mould, that deeper-rooted plants would find a proper bed for their nutrition, and by their multiplication and decay enable the larger trees to grow; and as their falling leaves augmented the accumulation of the nutritive matter, forests of every magnitude would flourish upon it.*

* Dr. Johnston mentions of the ash, that its winged seeds are so readily borne about by the winds, that no tree is so often met with in ruins and upon ancient walls. It insinuates its roots far into the crevices of these old buildings. In like manner it fastens upon loose slaty rocks, and adorns them with its verdure.—Flora of Berwick..... The plane has also wings; likewise the pine, though shorter..... "Those of the typha, dandelion, and most of the pappous kind, have long and numerous feathers, by which they are wafted every way."—Grew. Anat. p. 199.

Theophrastus noticed the distant conveyance of seeds by birds.—Plant. I. 2, c. 24.—And Pliny observes that the misseltoe was planted by them on trees, conceiving that its growing powers were increased by having been in the animal body.—L. 16, c. 44.....Tavernier remarked that birds from other islands swallowed the ripe nutmeg, but threw it up before digested, when it took root and produced a tree that would thrive better from them than if planted by human hands. Thevenot mentions the same fact.....The Dutch were so aware of the services of these

Water-plants are, by the peculiar nature of their seminal produce, by degrees spread along the rocks and shores of the ocean.* They form a distinct class of vegetation, which grows on the maritime localities to which it is most appropriated.† As on land, so at sea, some places are more adapted to one species of plants than to others.‡ Here, also, temperature affects them; for in those now growing on the coast of France variations occur in their evolution, corresponding with the season in which they appear.§

We do not know, nor can we now with decided certainty determine, what was the precise state of the surface of the earth when the command was given for vegetation to arise. We cannot now clearly ascertain whether the whole mass remained that globular level which its primeval rotation would cause its upper and external fluidity to assume, or whether the mountains arose from its abysses before vegetation began. On these points geologers have not yet agreed. But we may be sure that every plant which was then ordained to come forth appeared in its suited place,

feathered planters as to make it a capital crime for any one to kill them —Derham's Phys. Theol. p. 426, 427.

* Dr. Sloane remarks of the fuci, that the membrane which contains their seed or sporules "breaking, leaveth the seed to float up and down with the waves. This, coming near stones or any solid foundation by means of a mucilage it carries with it, sticks to them, and shoots forth ligulæ with branches; and in time comes to its perfection and magnitude."—Voyage to Jamaica, p. 50.

† The marine plants M. Lamoreux terms thalassiophytes, pursuing the French plan of taking their scientific nomenclature from the Greek. His essay on these has been said to have made an epoch in algology. Linnæus had seen only three kinds of these—fuci, confervæ, and ulvæ, —but Lamoreux has showff that they have several natural families; as in the phanerogamous vegetables. He proves that the hydrophytes have a more complicated anatomy than had been known. He divides them into the six families mentioned before.—Note to p. 138.

‡ Lamoreux has remarked that the basin of the Atlantic to 40° north lat. has a marked vegetation; so has the west sea of the Indies, comprising most of the Gulf of Mexico; likewise the east coast of South America; the Indian Ocean and its gulfs; and the shores of New-Holland and the adjacent isles. The Mediterranean has also a vegetation peculiar to itself, and extending to the Black Sea. Although Alexandria and the coast of Syria be geographically near that of Suez and the Red Sea, yet their marine plants differ in species.—Bull. Univ. 1830, p. 102.

§ "Algæ are there in the greatest abundance during the summer months; especially in strong heats. The temperature of the water, varying with the depth, has a corresponding action on the marine vegetation."—*Ib.*

and in such proportions and successions as would most effectually realize their Creator's intentions.

This is the correct and rational position of the subject; the philosophical certainty on which we may repose the satisfied judgment. Whether the primeval creation of vegetation was its instantaneous and universal diffusion over all the globe, or the emergence of it only on so much of the surface as would allow every species to appear, with a subsequent dissemination of it to every other part by gradual succession, still we may be sure that the same results would occur on either system. If the first formation were immediate and general, it would be but an instantaneous production of the same effects as the progressive diffusion would occasion. No spot could or would have the whole body of all plants upon it, but every place would have only its suited vegetation, whether immediately or gradual. The marsh and the seashore and the bed of the ocean would protrude those of the watery species; the rock would retain the lichen; the barren soils would receive the heath or the thistle; the valley would cherish those that suit the vale; and the mountain possess such as flourish best on elevated regions, as trees would arise in the localities fittest for their production. Each district would have at first what would grow best upon it, and all would begin the disseminating process as soon as their reproductive systems came into action. Diffusion is the law, and must have been in constant operation from the first period of their being. Those parts which had only the minor species of plants would have those of the higher classes, as soon as sufficient seasons and their decayed foliage had prepared a soil adapted to the germination of their arriving seeds. Whatever was brought or wafted would vegetate only there where it found a mould fitted for its nature; and thus, within a century after its creation, the surface of the earth would be in the same state as to its herbage and forests, whether they originated from a particular locality or from a universal formation.

It may be inferred from these considerations, that there is no occasion to indulge in the extravagant conjecture that the whole globe was for countless ages occupied only by plants. They would precede animals in all countries, because they diffuse themselves much more rapidly. No

quadruped out-travels the wind. No bird can reach distant islands, continents, or mountains faster than the never-tiring breeze. Nothing living multiplies more profusely and quickly than many of the botanic races. Hence it is natural that in our fossil remains vegetation should often be discerned where no traces of animal life occur; and it is not less so that it should have pervaded, more or less, every region of our globe, capable of habitation, at an early period after the creation.

The organic relics of our rocky masses correspond with the preceding observations, or are not inconsistent with them: and to these, which are the only real evidences we possess of the primeval vegetation of our earth, let us now direct our attention.

The rocky masses which constitute the crust or upper and external substance of our earth, display a visible succession and orderly formation. They lie, if viewed in their depth, above and below each other, although the lower are also found in some parts to rise up and form the mountains, as if they had been elevated from below; evincing thereby an abruption, an emergency from a subterraneous position, and great concussion and dislocation.* These are the rocks of the granite class, which are allowed to have been primordial, and to have issued upward from the inner substance of the earth.† The next masses of rocks, the lowest of all known except the granite, are also placed among the primitive formations. The gneiss is the most prominent of these,‡ and

* "The small part of the bark of the globe which we are acquainted with is composed of different mineral substances, which, considered in their mass, constitute ROCKS; some homogeneous; some visibly heterogeneous. The heterogeneity is not unlimited in the number, disposition, and relation of the parts. On the contrary, it shows in these a constancy which indicates that certain laws have governed these associations."

"The differences, and especially their organic remains, prove, as M. Cuvier remarks, that the bark of the earth was not made by a single cast; but that the parts which compose it have been successively formed or deposited."—Al. Brongniart. Struct. du Globe, p. 1.

† "Granite shows itself from the greatest known depths to an elevation of above 1200 yards above the level of the sea; from below the gneiss to the gypseous red sandstone; and in vast dikes, in many countries."—Al. Brong. *ib.* 338, 339.

‡ The GNEISS rocks are "one of the formations most abundantly spread over the globe. Some entire countries are almost wholly formed of it. It is the most ancient stratified rock; below which exist masses that are unknown on rocks not stratified. The summit of the Simplon, and most of the rocks of Sweden are formed of it."—*Ib.* 330, 331, 333.

all of this class were spread and arranged before any vegetables or animals appeared. The universal absence of all organic remains in these masses has led every one to this conclusion as a satisfactory certainty.*

But after these, organic remains begin to appear; of which only the vegetable ones shall be noticed in this Letter.

That vegetable remains abound in that series of rocks and masses which constitute the coal formations is universally agreed. Plants were therefore in being before the coal strata originated: and it is also now the general sentiment, that our coals are a transmutation of vegetable matter into that state,—an extended mass of mineralized peat or turf.† But it is not so generally admitted that this was the period of the first evolution of the botanical kingdom. It has been affirmed that no organic remains are found in rocks that were anterior to the coal formation.‡ But this idea has been disproved by later discoveries. Some places

* The mica slate rocks, and the quarzite ones, are, with those of gneiss, placed by M. Brongniart as so clearly prior to all organic life, that he calls them hypozoiques, or "inferior to all the rocks which contain organic remains."—P. 327. ...The limestone, and others which he notices, are usually placed among the primordial rocks, and most of them have no fossils of living substances.

† De Luc's theory on this is adopted by M. Brongniart,—that they are the turf bogs or peat mosses of the ancient world, that had become inundated by sea-water.—P. 280. .. De Luc repeats this idea in his last letters: "The substance of coal was formerly peat."—P. 155. And again declares it to have proceeded "from peat which underwent submersion by the waters of the sea. Fossil peat differs from coal only in this, that it has not been mineralized; and that the strata which cover it do not contain ferruginous masses; for, in other respects, the circumstances *are the same*."—Lett. p. 161. ....Marcel de Serres considers also that the vegetation of his first or antediluvian period formed the beds of coal.—Geognesie, p. 22....So Mr. Bakewell, Geology, p. 161; and Dr. Ure, Geol. p. 165.....Dr. Macculloch, also, whose valuable experiments have decided the question, ascribes to coal a vegetable origin. In his chapters on coal, lignite, and peat, he explains at length his ideas or theory on the vegetable conversion to lignite and coal.—Geol. vol. ii. p. 295-359. ..."The same action of water which converts the vegetable into peat can produce the further change to bitumen, as it does in the earth; though the time required is very considerable. The prolonged action of water has effected the ultimate change, as it has produced all the inferior ones; and has changed peat into perfect lignite."—*Ib.* 353. "Thus the progress of the change can be traced from the vegetable, through peat to lignite, and finally to coal."—*Ib.* 348.

‡ "At present, we know of no vegetable remains of earlier existence than those which belong to the coal formation."—Parkinson, Oryct. p. 31.

in England show that the limestone group below the coal contains vegetable fossils, although they but rarely occur.* It is therefore with propriety that the secondary strata, earlier than the coal, have been distinguished into two kinds, —those which, by never having fossil remains, prove themselves to have been anterior to all organic life; and those more immediately contiguous to the coal, in which portions or indications of plants occasionally appear.† The mountain limestone now and then exhibit them, though not frequently;‡ and in the sandstone of this portion very important fossil land vegetables have appeared.§

It is not in the coal itself that the organic relics of the old world appear, or very rarely.‖ But they abound in the sandstone and slate beds which form the usual roofs and floors of the actual mineral, and have been hitherto most numerously found in its shale superincumbent.¶ When

* In the Fossil Flora now publishing with so much care and taste by Mr. J. Lindley and W. Hutton, it is stated, "Vegetable fossils occur in all the sandstone and slate beds of the coal formation; and in many of the members of the subjacent limestone group."—P. 15..... "The limestone itself has hitherto afforded but few vegetable remains: nevertheless, we shall have to notice in the process of this work some beautiful examples, both from the limestones of Northumberland, and from those in the neighbourhood of Edinburgh."—P. 16.

† M. Al. Brongniart divides the rocks more ancient than the coal into these two classes,—hypozoiques, or under all living things; and epizoiques, or upon what have been such.—Al. Brong. Struct. p. 320..... Dr. Macculloch remarks, that "marine vegetables occur in the old schists."—Geol. vol. ii. p. 297.

‡ It is in the mountain limestone, transition limestone, his hemilysiens calcareux, that M. Al. Brongniart places his Tableau No. 18, consisting of three fucoides, or sea-plants; two calamites; a sphenopteris, cyclopteris, and pecopteris."—Struct. p. 431, and 292, 298.

§ "The Cragleith fossil-tree, pinites withami, was "found in 1826, in the great quarry at Cragleith, near Edinburgh, which we take to be in a sandstone considerably *below* the coal formation proper, perhaps even in the mountain limestone group. It was 36 feet long, and 3 feet diameter at the base. It seems to have been a tree having an exogenous structure."—Lindley's Fossil Flora of G. Britain, p. 9, 12. The editors cannot quite decide that it belongs to the coniferous tribe. In 1831, a branch of a tree was found there. "The concentric circles, medullary rays, and pith of an exogenous tree are distinctly seen."—*Ib.* p. 13.

‖ "The coal itself very rarely retains any marks of organic structure."—L. & H. Fossil Flora, p. 16.

¶ "Where shale forms the roof of the workable seams of coal, as it generally does, we have the most abundant display of fossils. The fine particles of which they are composed having settled up, and retained in wonderful perfection and beauty the most delicate outward forms of the vegetable structure."—Fossil Flora, p. 16.

such a roof is broken and falls, they become immediately visible in all their interesting abundance.*

The primeval vegetation thus disclosed to us has been described to be principally of the cryptogamous kind: ferns and fern-like plants, of the horsetail and club-moss tribes, with some of the palm and liliaceous species of the monocotyledonous description,† besides grasses, reeds, and succulent plants.‡ These have been considered to present to us the extent of the earliest antediluvian botany.§ In this enumeration, none of the higher orders of vegetation appear,‖ nor any that betray a marine origin. All those which

* "Their principal deposite is not in immediate contact with the coal, but about twelve or twenty inches above it. Such is the immense profusion in this situation, that they cause accidents by breaking the adhesion of the shale-bed, and causing it to separate and fall. After an extensive fall of this kind, it is a curious sight to see the roof of the mine covered with these vegetable forms: some of them of great beauty and delicacy."—Lindl. & H. Fossil Flora, p. 16.

† M. Marcel de Serres considers the remains of the first period of vegetation to have formed the coal-beds. "They are remarkable for their little variety; for the simplicity of their organization, and for the largeness of their size. They seem to be referable to two chief classes of the vegetable kingdom,—to the vascular cryptogames, as the ferns, the horsetails, and the club-moss tribe; and to the monocotyledons: but of these only a few that resemble palms and arborescent liliaceous plants."—Geognosie, p. 22.

‡ "In the argillaceous and bituminous slate, forming the floors and roofs of coal mines, are vast collections of the black bituminized remains of gramina, junci, cryptogamic, and other plants; agreeing in their general character with those of succulent plants, but differing from the recent ones known in Europe by their vast magnitude, and by the richness of the ornamental markings which appear on their trunk."—Park. Oryct. p. 10.

§ M. Al. Brongniart's Tableau, No. 17, gives a long list of them, of which the substance is—"no kind of marine plants; all land ones.—Equisetum, or horsetails; calamites; 12 species. Of FERNS, 21 kinds of sphænopteris; 2 of cyclopteris; 11 of neuropteris; a glossopteris; 46 species of pecopteris; a lonchopteris; 5 kinds of odontopteris; 41 of sigillaria. Of marsileaceæ, or the pepperwort tribe, 7 species. Of the lypopodiaceæ, or club-moss, 10 species; 2 of selagmites; and 34 of lepidodendron; 5 of lepidophyllum; 4 of lepidostrobus; 5 of cardiocarpon; and 8 of stigmaria; 3 palms; a canna; and 14 species of four monocotyledons."—Al. Brongn. Struct. p. 426, 427.

‖ M. *Adolphe* Brongniart's note on the preceding enumeration is,—"From which it results, that we have not found in the coal formation any plants of the classes of the agames, the cellular cryptogames, phanerogames gymnospermea, nor phanerogames dicotyledons: while of about 200 known species, there are more than 180 belonging to the vascular cryptogames, and 20 to the phanerogames monocotyledons."—*Ib.* p. 427

accompany the coal formation in England are land or fresh water plants :* those which indicate their residence in seas, are in the limestone above them.† But as the coal strata in our northern districts have been more fully examined or explored, the scientific naturalist is compelled to enlarge his ancient catalogue. Dicotyledonous plants have been recognised there, as we have already noticed.‡

The most frequent species of vegetables in our coal mines is that which is not yet definitely classed, but for the present is called CALAMITES. From their abundance, they are supposed to have formed the most prominent feature in the most ancient flora of the world.§ "They appear to have been branching plants, with hollow stems, and a distinctly separated wood and bark, often many feet in length, and their whole substance so soft as to offer little or no resistance to pressure."‖ From having wood and bark, they are now thought to be of the dicotyledonous description.¶ The English mines furnish some curious specimens of these relics of the vegetation of our earth in the days of its youth, about four thousand two hundred years ago.**

* "We only find these terrestrial, or lacustres vegetables. No shell; no fish of an origin purely marine is cited in the coal or in the coal rocks properly so called."—Alex. Brongniart, p. 280. . . . . "Almost all naturalists agree on this important point."—P. 281.

† "The magnesian limestone which lies immediately over the coal is very poor in fossil vegetables. Only 8 species have been described; all fuci, or sea plants."—Ed. Rev. 1830, No. 103, p. 62. . . . . In his Tableau, No. 16, M. Al. Brongniart has given the list of these—8 species of fucoides; and one zosterites.—P. 425. . . . . He says that the organic remains in this lead us to infer that these rocks have been formed at the bottom of sea-water.—P. 252.

‡ See before, Note [§] p. 173, and the Note [‖], on this page.

§ "More abundant stems of this occur in the beds of the carboniferous formations of the north of England than any others."—Lindl. Foss. Flor. 49.

‖ Fossil Flora, p. 50. "Some have supposed these fossils to have been analogous to reeds; whence the name calamites. Adolphe Brongniart endeavours to make out a close affinity to equisetum; but the presence of wood and bark is an objection to this. Nothing of this kind is known either in recent equisetaceæ or in any endogenous or monocotyledonous plants."—*Ib.* p. 53.

¶ This "is strictly characteristic of exogenous or dicotyledonous plants. We should rather consider calamites as the remains of some dicotyledonous plants; the affinity of which, if any exist, is still to be traced."—L. & H. Foss. Flora, p. 53.

** See the calamites nodosus in the 15th and 16th plates of No. 2 of the Fossil Flora, from the roofs of Felling colliery; and the specimen of the 20th, from the coal of Jarrow.

The lepidodendrons are the most abundant fossils, "after the calamites, which are found in the coal formations of the north of England, and are sometimes of a large size. Fragments of stems occur from 20 to 45 feet long."* Our scientific botanists have not yet ascertained to what present class of vegetables they have most assimilation. Their stems were soft, for they have been found compressed into a thin plate; they have a thin bark, and were of great length. They were neither trees of the pine class, nor low creeping plants, though they had some qualities of each of these.†

Another plant, very similar to the last, has been seen in the Jarrow colliery, which has yet so much indication of being of a different nature as to be called a lilodendron.‡

The fossil cones, called lepidostrobi, are so like the young shoots of the pinus genus, that they are considered to be reproductive bodies—the organs of fructification of some tree or plant.§

The sphenophyllum erosum is a pretty figure. It is most analogous to ferns or coniferæ, among recent plants, but more nearly related to the latter than the former.‖

*Fossil Flora, p. 17. "We have ourselves measured, in the shale forming the roof of the Bensham coal seam in Jarrow colliery, an individual of this class four feet and a half *in breadth*."—*Ib.*

† "Upon the whole, we are led to conclude that the lepidodendron genus was not exactly like either coniferæ or lycopodiaceæ; but that it occupied an intermediate station between those two orders, approaching more nearly to the latter than to the former."—Fossil Flora, p. 21..... Plates 4, 7, 8, and 12 of this valuable work represent those figures of the lepidodendron, from the shale forming the roof of the low main coal seam in Felling colliery, near Newcastle-upon-Tyne."—P. 15.

‡ Fossil Flora, p. 23, plate 5, is a specimen, from the roof of the Bensham coal seam, of the ulodendron magus; and plate 5 exhibits one of the ulodendron minus, from the South Shields colliery in Durham.—Brongniart calls it a "lepidodendron ornatissimum."—Prodr. p. 85.

§ They "are much more common in company with ferns and calamites than with lepidodentra. Of four specimens,—in one, a single large cone lies among fragments of ferns; in a second, five were with a few indistinct casts either of a calamites or the stalk of some large fern leaf; in a third, there are 9 lepidostrob, with a morsel of some calamites, and a fragment of the leaf of some neuropteris; while in the fourth, a single cone lies among fragments of calamites, and various fern stems."—Foss. Flor. p. 37.....Two specimens from Bensham coal seam are given in plates 10 and 11.

‖ Foss. Flora, 43. Mr. J. Lindley and Mr. Hutton have, for the reasons they adduce, "scarcely any doubt that it was one of these plants

There are several others, which have been denominated astrophyllites. One kind has some similarity to a calamite. Its stem was cylindrical, with intermedia about twice as broad as long, with verticillate leaves, and a bark of considerable thickness in proportion to the whole diameter.* The bechera grandis differs from these by its tumid joint and deeply but widely furrowed stem.†

The fossil trees called pinites, of the coniferæ, or pine class, also occur. One of the most remarkable of these was found 72 feet in length, in a grindstone quarry near Newcastle.‡ Another, in Cragleith quarry, was but half this length.§ In general, it is the impressions left by the perished vegetables on the mass that enveloped, which are oftener met with than the plants themselves.‖ But all such organic remains are only occasional or partial specimens of the antediluvian vegetation. The great body of this exists in the extended coal itself. In that it has been compressed, converted, and mineralized, till it has lost all traces of its primeval figure and substance, and has be-

which, in the ancient world, represented the pine tribe of modern Floras."—*Ib.* p. 44.....It is "very rare in the shale above the Bensham coal seam."—P. 41.....But beautiful specimens of it have been found elsewhere. It is figured in plate 13.

* Fossil Fl. 45. "The only inference that can be safely drawn seems to be, that the plant was *not* endogenous."—*Ib.* 46.....This was asterophyllites tuberculata, plate 14. The ast. grandis, in plates 18 and 19, appears to have been a plant of considerable size, with numerous verticillate branches and v. subulate leaves arising from nodi, very remote from each other. It may be compared with calamites, from which it only differs in having its branches very imperfectly furrowed."—*Ib.* p. 55 ...The 18th plate is "an ast. longifolia, differing specifically from the first in the much greater length of its leaves."—59.

† See it in the 19th plate of the Fossil Flora.

‡ At Wideopen, near Gorforth. "Its bed is considered one of the highest members of the coal formation. It lay nearly at right angles with the dip of the shale. The direction was nearly north-east and south-west. It tapered gradually from the bottom, which was four feet nine inches to the tip, which was eighteen inches in breadth. A thickness of thirty feet of solid stone had been worked away before it was discovered." Fossil Flora, p. 2, plate 1, is a striking representation of a portion of it.

§ See before, Note [◊], p. 173.

‖ Thus, "many impressions of calamites occur in the sandstone of the quarry."—Fossil Flora, p. 5. . . "In many of the sandstones, although the fossils are numerous, it is only the large and strongly-marked individuals which have left these forms impressed upon the rough-grained mechanical deposite of these rocks; when their bark or outer coating is generally found converted into a fine coal."—*Ib.* p. 15.

come a wide-spread mass of carbonaceous and inflammable matter, long reserved, and now disclosed for human use and comfort.*

There is nothing in these primeval plants that discovers a system of vegetable nature or structure in the least contrary to our own. Some no longer exist; but of many of these we now have species which are analogous to them.† The more we know of the less-frequented parts of our present globe, the more exact similarities we are finding to them.‡ The great and marking difference seems rather to be, the enormous size to which what are common plants with us the antediluvian ones appear to have reached. It is in their superior magnitude to ours that they present to us a state of botanical nature so far different from them; not in configuration, organization, or essential economy. Kindred likenesses, though not identity, are still the accompanying features.§

Assuming, with the ablest geologists who have most combined botanical with mineralogical knowledge, that vegeta-

* It is not improbable that the coal beds in every country represent to us where the chief localities and exuberance of the primeval vegetation were situate. Wherever they occur, there we may presume the ancient plants were profusely abounding when the transforming catastrophe came upon them. A deluge offers natural causes to us for this destructive but ultimately useful change. The great torrents of mingled earth and water, which at that period must have been rolling around, as they poured and settled on the primitive valleys and plains, would produce that pressure, moisture, exclusion of air, confined moderate warmth, and sandy superincumbents, which appear to have been the producing causes, as they would now be, for converting plants and wood into coal.

† "In the middle of the forms which seem no longer to exist, we discover in a great number of them similitudes to those which characterize our present races."—M. de Serres, Geogn. Int. xiv.

‡ "The number of species considered as lost is diminishing every day; while those of the fossil kind which are analogous to our existing races are continually augmenting, in proportion as we better know the various productions of distant countries, and even of our own region."—*Ib.* xv.

§ "The species which we look upon as destroyed do not differ more from those we have and see, than those which live in New-Holland, from the natives of our old continent."—De Serres, *ib.* xv.

The minute discriminations of Mr. J. Lindley and Mr. W. Hutton, in their Fossil Flora, do the highest credit to their scientific exactness and love of the precise truth minutely ascertained; but they fully show how much alike the things often are which they distinguish from each other, so much alike, that the differences carefully marked by them did not often excite the notice of Adolphe Brongniart and other able naturalists.

tion preceded all animal being,* just as Moses has stated, we have also to observe, that if we judge of the primordial plants from some of the specimens in our downward excavations, our first impression will be that they were of a gigantic character. These certainly display dimensions which far transcend any of the same species which are now upon our globe. Ferns as large as our tallest trees, and moss-like plants, equalling the size of the timber of our forests,† dispose us to look upon the primeval world as an anterior counterpart to that kingdom of Brobdignag, which Swift imagined as a satirical possibility. It is true that on our present earth we find the moderate herbaceous plants of our temperate climate to attain extraordinary magnitude in the torrid zone.‡ Ferns there become arborescent.§ Reeds rise in the hot regions of North America in vast masses.‖ Some weeds of the same parts are extravagantly high.¶ Water-plants also attain there an unusual size;**

* In the opinion of M. Adolphe Brongniart and of his reviewer, "The antiquity of the formations in which the vegetables of this, the first period, are found, prove, what we might admit à priori, that life began on the earth by the vegetable kingdom."—Bull. Univ. 1829, p. 2.

† M. de Serres, p. 13.

‡ "The plants of the three families of the ferns, the club-moss, and the horsetails acquire always a size so much the larger as the climate in which they grow is hotter. They are nowhere so hot as in the regions which are both hot and wet, as those of equinoctial America and the isles of the Asian archipelago."—Ad. Brong. Bull. Univ. 1829, p. 8. M. Serres, 13.

§ Many of our voyagers and travellers have remarked this circumstance in the Polynesian seas, ferns assuming the size and character of trees.

‖ "The cane-brake is a swamp filled with arundo gigantea. It grows on the lower courses of the Mississippi, Arkansas, and Red River, from fifteen to thirty feet in height, in equidistant joints perfectly straight, and almost a compact mass. The smallest sparrow would find it difficult to fly among it: with its ten thousand stems rising almost contiguous to each other, and the impervious roof of verdure it forms at top, it has the aspect of being a solid layer of vegetation."—Flint's Geog. of West. States, vol. i. p. 80. Wilson also mentions morasses covered with reeds ten feet high.

¶ "The weed stramonium is in a great part of the western country. On the richest bottoms it grows fifteen feet in height, and of a size and compactness to turn away cattle."—N. Amer. Rev. No. 62, p. 92.... Wilson, in his Ornithology, describes the *mosses* on the leafless limbs of the cypresses as being from two to ten feet long, and hanging down in such quantities that fifty men might conceal themselves in one tree.

** "Among the following aquatic plants, one for magnificence and beauty stands unrivalled, the nymphæa nolumbo. We have seen it of the greatest size and splendour on the lakes of the Arkansas. It rises,

as thistles spread in similar largeness of proportion, and clover likewise, over the pampas near La Plata.* Marigolds and chamomile are not in less ratio of dimensions in the north of Africa.† Weeds are also still gigantic in the Asiatic seas.‡ But it is stated by men of science, that the primeval plants far exceeded these large dimensions ;§ that ferns of the ancient world were double the size of our torrid ones ;‖ and that its horsetails and club-moss were still more gigantically aggrandized.¶ It also appears that the same kind of vegetables are now more numerous in the islands of the torrid zone than on the continent; and among these the ferns, and their kindred families, peculiarly preponderate.** From these circumstances it is inferred, that the antediluvian vegetation grew in a climate more hot and moist than that of the equinoctial regions and

from a root like a cabbage-stump, in the water, from three to ten feet. The largest leaves are of the size of a parasol."—Flint, i. p. 89.

* Mr. Head, in his journey through the pampas, mentions plains of thistles ten feet high. Mr. Beaumont, in his Travels in Buenos Ayres, speaks also of "forests of *thistles*, like underwood, used for fuel. We find *clover* growing so high, that men and cattle, passing through, cannot see each other."—P. 16.

† Captain Beechey says of the ruins of the ancient Ptolometa, "The greater part of the town was thickly overgrown with wild marigolds and chamomile to the height of four or five feet."—Trav. in N. Africa.

‡ "The fucus pyriferus of Linnæus is, after the calamus rudentium, the *longest* of vegetables. It reaches a height of 300 feet. The fucus buccindalis at the Cape is not so long, but floating on the water, it becomes the abode of aquatic birds."—Bull. Univ. 1830, p. 437.... Dr. Mertens describes many gigantic fuci which he saw. In the environs of Illulak, the leaves of the fucus esculentus often attain the size of those of a banana. The sea had brought into Valparaiso Bay many gigantic fuci, which the poor used for food. The fucus clathrus covered the sea near Unalasca.—Bull. Univ. 1830, p. 256.

§ "They present a development, a largeness, and a force of vegetation superior even to what the *same families* acquire in our equatorial regions."—Ad. Brongn. *ib.*

‖ M. Ad. Brongniart's statement is, that "The arborescent ferns, though analogous in some respects to those which now grow only in the torrid zone, rise to a height double to that which the tallest attain there. They are forty and fifty feet high; while ours never exceed twenty or twenty-five feet at the utmost, and the largest number only rise to eight or ten."—*Ib.* 7.

¶ "The lycopodes (club-moss) and equisetacées (horsetails) are now only herbaceous plants, or at most like shrubs but a few feet high; but among the plants of the coal formation, the horsetails of the calamite genus are from ten to fifteen feet or more; and the club-mosses, which form the genus lepidodendron, are sixty or seventy feet in height."—*Ib.* 7

** Ad. Brongn. p. 8.

of Polynesia;* and rather in scattered islands in the middle of a spacious ocean, than on a large continent.† The tendency of the latter idea would be to induce us to think that the antediluvian world partook very much of this insular character.‡

There is much probability in these hypothetical deductions; but we can as yet only receive them as ingenious inferences from the facts of our present knowledge, rather comparative than direct. Further observations will either confirm or invalidate them. For these let us wait, without confounding conjecture with certainty. In the mean time we may remark, that the causes from which the unusual enlargement of plants arise are not yet sufficiently understood. Many now become greatly aggrandized even in the temperate zones.§

But there seems to be no reason for declining to adopt the supposition already mentioned, that the coal formation contains the destroyed masses of the earliest vegetation, in

* Ad. Brongn. p. 8.

† "If scattered isles existed in the middle of a vast ocean, without any large continent, their flora would have the character of the flora of this first period of vegetation, as to the numerical relation of the plants to each other."—Ad. Brongn. p. 8.

‡ "These two considerations, of the numerical relation and size, compared with what is now seen on the earth, induce us to think that at the coal formation,

"1. The uncovered surface of the earth formed only isles or archipelagoes in the middle of a vast sea without large continents.

"2. That the temperature of these isles was much higher than that of any part of the present earth:

"And as the fossil vegetation of the first period presents everywhere nearly the same characters, we would infer that this higher temperature was more uniformly spread over all the surface of the globe."—*Ib.* p. 9.

But when this idea is pressed to represent the ocean as "an immense sea of hot water," our cautious reason cannot but pause, and decline to sanction a notion which has the aspect of much extravagance.

§ Thus, as Mr. G. Burnett mentioned, "meadow clover though but twelve inches in its ordinary height, sometimes reaches to four feet. The poa trivialis has been found ten feet long; and horse-chestnut leaves twenty-two inches across. The florin grass, on barren soils and the seashore, seldom exceeds four inches in height; but Dr. Maton collected specimens seven feet long at Orcheston.... In a fertile soil it will produce 18,000 lbs. weight of hay per acre."—Quart. Jo. Sc. No. 10, p. 361. ....So Dr. Hooker remarks of our present willows and osiers. The larger kinds, which are, too, of the most rapid growth, yield timber, and exceed 60 feet in height; while the least of them, which grows at the summit of our Highland mountains, can scarcely be said to rise above the surface of the soil in which it vegetates."—Hooker's Brit. Flora, p. 412.

the places where it occurs; since De Luc's idea, that coal is but the mineralized peat of the primeval world, is admitted or adopted by the most intelligent geologists.* The present formation of turf corroborates this theory.†

On the rocks whose masses destroyed the first plants, and remained upon them, the next vegetation would of course appear. This seems to have been marine plants; which imply that the waters of the sea were then inundating the land. The beds containing this are the magnesian limestone and the new red sandstone.‡

As later rocks, in that period of convulsion and agitation, formed on the preceding masses, another vegetation appears. In these newer strata, from the lias to the chalk, remains of plants of a somewhat different kind from the primeval are found. Some of these plants have been thought to possess more complicated organization than the former, and to be more similar to those which now arise from the ground.§ The larger dimensions disappear, and the lycadeæ and coniferæ occur; both of the gymnospermæ tribe.‖ Though distinct plants from the prior ones,

* M. Ad. Brongniart thinks the coal depôts to be vast turf or peat bogs, very different from our present ones, from the nature of their vegetables, and the climate under which they were formed, but composed, like them, of the detritus of vegetables, which had grown on this lower and more humid soil. "The beds of the ancient tourbieres have been buried by a deposite of beds of sandstone or clay. These turf-beds must have been reproduced in several successions, to have formed so many beds of coal as compose one and the same coal formation. They have been completely covered; and the vegetation from which they originated has been destroyed by some great catastrophe, contemporaneous with the ejection of the porphyries, which, in many places, cover the coal formations." Ferussac, Bull. Univ. 1829, p. 10.

† M. Dau, in his Essay on the Turf in Germany, concludes, that for the turf to form, there must be these three circumstances:—1. The vegetable fibres should be under water, or constantly moistened at the surface. 2. The air should be excluded. 3. The temperature should be in general low; the mean under 16° Reaumur.—Bull. Univ. 1830, p. 200.

‡ Al. Brongn. Struct. 249–252.

§ Bull. Univ. p. 2-10. "Alex. Brongniart enumerates the plants of the lias and keuper rocks as equisetum, glossopteris, pecopteris, clothopteris, tærnopteris, marantoidea, lycopodites, culmites, mantalia, and seven kinds of cycadées."—Struct. p. 420.

‖ Lindsey, Nat. Syst. 245.... Dr. Sprengel thinks that the cycadées form the passage from the palms to the ferns. He remarks, that in the fossils of the red sandstone and the porphyry the ferns predominate over the monocotyledons, but that the contrary prevails in the most recent formations. Bull. Univ. 1830, p. 455

they greatly resemble them,* and indicate a lower temperature, and that the sea was no longer invading the land.† There are fewer of the ferns, horsetails, and club-moss tribes; and as the new beds and rocks occur, even the monocotyledons lessen, and the superior classes of vegetation appear.‡ The distinction has been made, that in the older beds of the gres bigarré there are no cicadées; and that these are seen for the first time in the secondary rocks which lie above the calcaire conchylion, or muschelkalk.§ They continue to appear, with various modifications, up to the chalk formations;‖ but the dicotyledons were very rare. Yet upon these statements, it will behoove us to recollect that our coal formations show that it is erroneous to suppose, that no plants of the more complicated organization were among the vegetation that was overwhelmed. We must not mistake rarity or absence for non-existence.

The last period and kind of vegetation which the buried remains disclose, and the most like our own, is comprised in the whole series of the tertiary formations; those which have been deposited *after* the chalk was formed, and which

*"So great is the resemblance between lycopodiums and certain coniferæ, that I know of no external character, except size, by which they can be distinguished."—Lind. *ib.* 245. The cycadeæ have great proximity to the ferns. The coniferæ are the fir tribe.—*Ib.* 246, 247.

†"This indicates a greater extent of earth out of the ocean; a temperature less elevated; and genera of vegetables, which approach those that are now prevailing, and especially such as grow in the equatorial regions."—Ad. Brongn. p. 10.

‡M. de Serres thus states the difference: "The second period of vegetation comprises our upper secondary formations, of which the chalk is part, and still has a great many of the vascular cryptogames. At first they are about equal to the phanerogames gymnospermæ, which the coniferæ and monocotyledons represent, in the most ancient of these rocks, as the gres bigarrés; but they gradually lessen, and the others increase, especially the cycadées. It is in the beds above the muschelkalk that this vegetable becomes most sensible. The essential difference between this vegetation and the former is, that the vascular cryptogames diminish more and more as the beds they are buried in are farther from the lower secondary formations, and because these plants did not acquire such a large development as in the period when they alone formed the chief part of the vegetation."—Geognosie, p. 23, 24.

§M. Serres, p. 25... M. Adolphe Brongniart, from this distinction, made two periods of vegetation—his second one, without the cycadées; his third, with them. ... M. de Serres thinks these ought to be comprised in one era, and therefore includes both in his second of the three periods within which he confines the fossil plants.—*Ib.*

‖Serres, p. 25.

have been also named rocks de sediment supérieur.* This period is essentially characterized by the general presence of dicotyledons, which from that time acquire a remarkable predominance in number over all the others. The proportion to each other of all the vegetables then on the globe was much the same as it is now; and as the plants differ little from ours, they do not indicate any dissimilarity between the climates of that remote period and of the present.†

"All this last vegetation, taken in the whole, was composed, like that which now covers our surface, with numerous and very varied plants, analogous in their families and genera to those which are still subsisting on it. Their great classes are the same in their numerical relations. The dicotyledons were at least, as now, four or five times more numerous than the monocotyledons. Only a few traces of ferns, horsetails, and mosses appeared; and the agames are only represented there by various species of sea plants."‡

In this view, the vegetation of the various countries whose

* Serres, p. 26.

† Serres, p. 26, 27. "This analogy between the destroyed vegetation and the present one is particularly striking, when we see the remains of the first in the most recent beds of the tertiary formations. It is much the same in the lower beds, where every thing is conformable to our vegetation, except some families now peculiar to the hot countries."—*Ib.*

‡ M. de Serres, p. 27. This gentleman thus sums up his review of the three periods of the fossil, or primitive, or antediluvian vegetation:—

"The 1st period is essentially characterized by the numerical predominance of the vascular cryptogames, and by their large dimensions. The flora of this period approaches the vegetation of the small islands situated between the tropics, and at a great distance from the continent.

"The 2d era, in which the vascular cryptogames are at first in equal number with the phanerogames gymnospermes, closes by the predominance of the latter, and by the appearance of the cycadées. It is distinguished in all its successions by the smaller size of the cryptogames. Thus the flora of this epoch presents some of the characters of the vegetation of great islands and of the seashores.

"The 3d period, the most recent of all, exhibits, for the first time, the vegetables of all classes which are now growing; among which, as at present, the dicotyledons are the most numerous; then the monocotyledons, the phanerogames gymnospermes: and in the last rank, the cryptogames and the agames. The flora of this era is analogous to the vegetation of temperate continents; and especially of the large forests of Europe and of North America.

"Such is the progress of the vegetation of the earth, which we have traced after the observations of M. Adolphe Brongniart, with a slight modification. Hence it results that this vegetation has become more and more varied."—Gest. p. 29.

remains have been explored, which are chiefly the European regions, is represented to have been chronologically progressive. "At first limited to two principal classes, it afterward presents three; and, later, five." The first plants are the most simple; the subsequent ones display a more complicated structure.* But it is now certain, from the latest discoveries of English mineralogists, that what are thus called subsequent were in contemporary existence with the simpler.

Vegetables with woody fibres in the centre of their trunks have been found in the new red sandstone that lies upon the coal sandstone in the Cold-stream rocks, near the Tweed, in Berwickshire. They appear to be dicotyledons.† This fact proves, in addition to those noticed in the preceding part of this Letter, that although this class of vegetables are not in every coal district, yet that, at the era of their formation, such plants were existing on the earth, and are actually visible in several rocks, and therefore that they were not the creation of a subsequent age; for if one be found to exist, it overthrows the assumption of a later nativity. This fact destroys the theory that simple plants first appear and live for ages, and that then less simple ones arise from them, and that in future centuries the more perfect come into being. There is no science in a theory of this sort, because nothing is more certain in nature than that every plant is the product of a specific organization, and only of that, and never changes into any other. A rose may be improved from the simple corolla of the wild brier to the rich and numerous one of the cultivated rose. This is but like a cradle child nourished into the vigorous man.

* M. Serres, p. 29.

† Mr. Witham has described these rocks and plants in the Annals of Philosophy, July 1830, from the cut at Lennel Braes: "All the plants are in a very irregular position. By dividing the trunks of some on a peculiar plan, he has discovered their genera. They cannot be vascular cryptogames, because they contain ligneous fibres in the middle of the trunks. They are not monocotyledons, because the woody parts are not composed of bundles disseminated in the parenchymatous texture, which does not prevail in them. They have a medullary structure—radiated, and appear to be dicotyledons. These trunks are bent and flattened. They have rotted, and their decomposed parts have been replaced. The highest part of the trunk was four feet round, and the lower six. M. Ad. Brongniart therefore erred in saying that only vascular cryptogames occur in the coal formations."—Bull. Univ. Aug. 1830, p. 308.

But no rose can by any art, or ever has been by any natural effort, transformed into a carnation; neither has a cryptogame ever enlarged into a monocotyledon, nor that into a dicotyledon; or, in other words, no moss has become a field of wheat; nor has corn ever changed itself into a forest of elm and oak. The hypothesis, therefore, of nature progressing gradually from the simple to the complicated, has no foundation in any visible fact. No lichen has ever changed into a moss, or a moss into a fern, or a fern into corn, or corn into a forest tree. Each plant only reproduces its own species, and never any other. Nor can it be more difficult to Omnipotence to produce a fern than a lichen, or a pine than a moss. Whenever it operates by progression, it does not use this process because it could not act instantaneously; but because the gradation is a fitter means for its great purposes than immediate completion. But though vegetable dissemination is a progressive event, its successions are very rapid: instead of ages being required to revolve before the larger productions arise, a single one would suffice to clothe the most barren coral or ejected lava with no small proportion of a vigorous and varied vegetation. All the erring theories that have been unsuccessfully started to which we have alluded are, too often, the vain attempts to account for the formation of all things without a Creator. Such efforts must always fail; as no causation but his own will ever be found sufficient for the effects that are around us, in the calm judgment of the truly philosophizing inquirer.

If therefore it had been true, that nothing but ferns and mosses were in being where the coal masses were formed from them, this fact would only show that other vegetation had not at that time become disseminated into those parts. It does not prove that other plants had not then been created, nor that they were not at that time elsewhere existing. The correct conclusion from such a fact would only have been, that the seeds of other plants had not before that time reached these places; for, the largest portion of the surface of the earth has not the coal formations. "The coal series is situated between the older and the newer red sandstones."* "The British Islands possess one of

* Dr. Macculloch's Geol. vol. ii. p. 302.

the most extensive deposites of coal yet discovered."* But though it exists more largely than is known, yet it has not been hitherto found very extensively in Europe. So many districts and countries are without it, that we are not entitled even to infer that what occurs in coal-mines is sufficient to indicate that no other vegetation was then in the rest of the world than what appears in them. The true reasoning would stand thus, if only cryptogamias had been traced in them; but the discovery that some of the most perfect plants have been also found in or near them compels us in sound reasoning to conclude, that the perfect plants were then created, and were then existing on earth, as well as what are deemed the simpler and less complicated. Thus the hypothesis of a gradual formation from age to age, of the higher and of the lower, is untenable and unscientific.

These reflections lead us to what seems to be the true philosophy on the subject, which will always be the companion and the representative of the actual reality. The original creation of all the classes of plants at the period of their first formation would be in those places where they were first meant to appear and to vegetate. From these regions they would be gradually disseminated to all the other parts, at successive periods, according as the moving agencies of nature should disperse them around.

In this view, it is exactly congruous with the laws of botanical nature, that the cryptogamic tribes should first appear in those soils which had none before, because the seeds of these are the lightest; float easiest on the air; are the most numerous; and can be transported by the winds and air to the farthest distances. Here, generally, they are wafted invisibly in the air, and always settle from it or whatever is damp, to begin their vegetation, because th moisture peculiarly suits their germination. We daily see from the little moss and mould and lichens which arise on our books and in our closets, and on all damp stones, walks, and places, that the number of the seeds produced by the cryptogamic kind exceed all that we should suppose before the fact had been ascertained.†

* Dr. Macculloch's Geol. vol. ii. p. 308.

† The fungi tribe give us a curious instance of the immense multiplicity of their seminal productions. Fries says of their sporules or seeds,

There seems to be much force in the reasoning, and much probability in the conclusion, that the first state of our habitable lands was that of small islands amid a mass of surrounding seas. This is not inconsistent with the Mosaic account. That records the order for the waters to congregate into one place, and for dry land to appear; but does not geographically describe or delineate the one or the other. Vegetation was immediately afterward ordered to arise. In the recession of the waters, it is very likely that the higher grounds—the mountain regions certainly—would at first be like islands; so many summits emerging into dry land as the waters sank or rolled off. On such islands as were first uncovered, the general vegetation would appear; and from these would disseminate to others, as they became freed from their aqueous incumbent. On these later dry lands the floating seeds would settle as they were wafted towards them: and the vegetation, which now is seen to arise first on new-formed islands is precisely of that character, which the coal masses show to have first been diffused in their localities in the primordial times.* The ancient vegetation of this sort having been so abundant, the deduction seems reasonable that the soil and climate where it grew were hot and moist, and therefore insular; because it is in islands of the torrid zone that the same kinds of plants are most predominating in our present days; and no general continent would have had so moist an atmosphere as these exuberant ferns and mosses re-

"Their sporules are so infinite, that in a *single* individual of reticularia maxima I have counted above 10,000,000; they are so subtile, that they are scarcely visible to the naked eye, and often resemble thin smoke; so light, raised perhaps by evaporation into the atmosphere; and dispersed in so many ways by the attraction of the sun, by insects, wind, elasticity, and adhesion, that it is difficult to conceive a place from which they can be excluded."—Linds. Nat. Syst. 335.

* So D'Urville found, and has noticed. "Pulverulent lichens are the first plants that clothe the bare rocks of newly-formed islands in the midst of the ocean; foliaceous lichens follow these, and then mosses and hepatreæ."—Ann. Science, vol. vi. p. 54.

"Mosses are found in all parts of the world where the atmosphere is humid. They are among the first vegetables that clothe the soil with verdure in newly-formed countries. The first green crust upon the cinders of Ascension was minute mosses. They form more than a quarter of the whole flora of Melville Island; and the black and lifeless soil of New-Shetland is covered with specks of mosses struggling for existence."—Lindsey, Nat. Syst. 324, 333.

quire for such multiplicity and magnitude.* Yet we cannot implicitly admit that the numerical predominance merely of these cryptogamias implies a hotter climate, for they really increase in their proportion now as they approach our North Pole.† It is their size, rather than their presence, which leads to the deduction as to the temperature. Unusual magnitude indicates unusual warmth and moisture in the northern climates. In Scotland a gigantic sedge has occurred ;‡ and near Leeds, in Yorkshire, a reed of enormous size.§ Such things seem to have required a higher temperature than those countries now enjoy. Yet in stating these instances, it is desirable to recollect that all such gigantic remains are not to be deemed the universal character of the primeval vegetation. The whole of it was not of such mighty dimensions. Plants of this magnitude certainly existed in it; but other calamites have been also found of a much less size.‖ It is probable that a considerable portion of the antediluvian flora resembled

* Thus, in the TROPICAL ISLANDS, although the ferns and fern-like plants have now sunk down to a proportion only of the whole that are there, yet they bear a larger ratio in such places than elsewhere. In Jamaica, they are 1-9th of the phænogamous plants. In New-Guinea, 98 to 122. In New-Ireland, 13 to 60. In the Sandwich Islands, 40 to 160. But upon the CONTINENTS their proportion has greatly lessened. Thus, "In equinoctial America, Humboldt does not estimate them as more than 1-36th. In New-Holland, Mr. Brown finds them 1-37th. They decrease in proportion towards either pole: so that in France they are only 1 63d; in Portugal, 1-116th; in the Greek Archipelago, 1-227th; and in Egypt, 1-971st."—Lindsey's Nat. Syst. 314.

† "Northward, their proportion again augments; so that they form 1-31st of the phænogamous vegetation of Scotland; 1-35th in Sweden; 1-18th in Iceland; 1-10th in Greenland; and 1-7th at North Cape."—D'Urville, Ann. Scien. Nat. 6, 51. Lindsey, p. 314.

‡ Mr. Ramsay collected the larger part of cyperacea, or gigantic monocotyledon, from the coals and stone of Craighill near Edinburgh.—New. Ed. Phil. Jour. 1830, p. 194.

§ "A fine specimen of calamites, a plant resembling our reed, but of gigantic size, was found at Quarry Hill a few days ago: it is at least fourteen inches in diameter."—Leeds Intell. Aug. 1829. ... "Gigantic reeds, resembling arundo donax, are found in the sea cliffs opposite High Whitby."—Dr. Ure's Geology, p. 201. ... Among the fossil remains of Tilgate forest rocks Mr. Mantell found large trunks like palms, arborescent ferns, and gigantic reeds of tropical climates.—Bakewell's Geology, p. 281.

‖ To the account of the Leeds fossil it was justly added, "This species is of common occurrence in our coal fields, to which the rocks of this neighbourhood exclusively belong, but is seldom found of so large a size. It is deposited in the museum of our Philosophical Society."

our own in its general appearance and dimensions, although with these extraordinary exceptions. It is now believed that the interesting arborizations which are admired in agates and chalcedonies often come from fossil conferva.* If so, the ancient confervas were not larger than those of our ordinary ponds, for their siliceous imprisoned ones have not greater dimensions.

Among many good treatises on the coal formations, the third book of the "Outlines of the Geology of England and Wales," p. 233–470, chiefly by the Rev. W. D. Conybeare, contains a very succinct and satisfactory statement of the principal facts concerning them, with that candid and intelligent reasoning upon them which distinguishes his work and his geological mind. If all our essays on geology had been written with the same temper, knowledge, precision, and logical tact, the science would have been kept free from many of the errors and prepossessions which have contributed to perplex and darken it. His summary of the organic remains in the coal-fields, p. 333–344, is followed by his observations on the theoretical deductions as to their origin, p. 345–349. He is disposed to think that the coal vegetables were accumulated in friths and estuaries; and buried there with the alluvial detritus that was swept away with them.†

* Daubenton, in 1782, first called the public attention to this fact. Dr. Macculloch adopted his opinion, as to their containing the true remains of vegetables.....M. Blumenbach, who at first opposed it, at last recognised the fructification of a plant approaching the sparganum erectum in an agate of Japan,.....Ad. Brongniart hesitated, because they were not perfect; but M. Raspail has confirmed the theory. By experiment on some existing conferva, he obtained figures like those in agates, which by compression anastamosed into arborisations.....Dr. Jaeger affirms, that in the Stuttgard museum there are three pieces of agate with the remains of vegetation.....Mr. Jameson has mentioned that chalcedonies are still forming in Iceland, which agglutinate naturally confervas and mosses.—Annal. des Scien. Feb. 1830. Bull. Univ. June, 1830, p. 450.

† The same gentleman's sketch of the progress of the science, (Introd. xxxviii–lvi.) is a pleasing exhibition of the labours and talents of several English geologers. The quotation from Professor Buckland's inaugural lecture ably states the services which geology, rightly studied, concurs, with other branches of natural history, to render to the noblest of our intellectual inquiries, natural theolog

LETTER VIII.

The Creation of the Fish and Whales—The General Principles of their Formation and peculiar Nature.

In the vegetable kingdom we have surveyed one grand division and display of organized matter, and of that living principle which is everywhere connected with organization. These two great peculiarities of nature are never separated. There is no organization without the principle of life. There is no life on our earth without a material organization within which it resides.

From the creations which we have described, the Deity proceeded to the formation of a very different description of material organization, and with a living principle of qualities much superior to any which appear in plants. This other grand division of life and organization is that which constitutes the animal kingdom. If we consider the mediums in which they reside, we should distinguish this order of beings into three general classes,—the animals of the waters, those of the air, and those which inhabit more immediately the land. But their respective forms and habits lead us to minuter divisions than these. Besides the fish, birds, and quadrupeds, we also find insects frequenting the air, and reptiles and worms the earth; and others, the amphibious class, which are alternately both on land and in water. Linnæus made an artificial classification, which has since been considerably altered by others. The crustaceous animals have been separated from his insects; and the testaceous ones from his worms. The molluscæ and infusoria have also received a more distinct consideration, and a different arrangement. All these form together another vast and multifarious evolution and portraiture of the Divine Mind, to the contemplation of its intelligent creatures. But although very diversified in external figures, and in their habits, yet they are all linked together by very close analogies of system, qualities, faculties, and living principle. They all display relations to

each other, and organical and instinctive affinities and similarities, which entitle them to be considered as one grand kingdom of organized life, originating from the same Designer and Creator; associated in many points with his vegetable system of it, though clearly separated by their sentient and other superiorities. Thus the living organizations of earthly nature are in two distinct compartments. One of these, the botanical, has been considered in some detail, because it represents to us the principle of life in the lowest degree of faculties and force, without apparent sense or thought, and acting on principles and to effects very dissimilar in many essential points to those of the animated races, amid all its analogies with them in others. But animals are more immediately linked together in all their functions and properties. Of these the aquatic tribes are the most peculiar, least known, and most fully separated from the rest; and will therefore be considered in these Letters rather more at large than the other orders of the animal kingdom. But of each of these we will endeavour to select such facts as will indicate the Divine system and object in their production, and as will contribute perhaps to throw some light on the nature and distinctions of that living principle, which has been appointed to accompany both the kingdoms of organic being.*

The new system of creation which is exemplified in the animal world was begun on the fifth day, in the production of the fishes and the birds. The order for their appearance is thus expressed:

> And ELOHIM said, "Let the waters bring forth *abundantly* the moving creature that hath life, and fowl that may fly above the earth in the open firmament of heaven."†

Thus the two earliest classes of animated beings were those that were to inhabit the two fluid mediums on our globe,—the water and the air; both compounded substances —specific compositions of oxygen, with different additions.

* "Animals enjoy sensation by means of a living organization, animated by a medullary substance; perception by nerves; and motion by the exertion of the will. They have members for the different purposes of life, organs for their different senses, and faculties or powers for the application of their different perceptions. They all originate from an egg."—Turt. Linnæus, vol. i. p. 4

† Gen. ch. i. ver. 20.

Water is the combination of oxygen with hydrogen: the atmosphere is its union with azote. But neither of these result from a promiscuous mixture of their component parts. One definite proportion of oxygen with one fixed portion of hydrogen will alone produce water.* Another proportion of oxygen with a determined quantity of azote, is requisite for the formation of the air which we and all earthly animals respire.† Any other proportions of either will make very different substances. The two elements are therefore as chosen, appointed, and specific things as the creatures are that inhabit them; and these creatures have been deliberately formed with exact adaptitude to the properties of the several mediums they were to live in. Nothing can more strongly indicate a reasoned creation.‡

Fishes, like vegetables, are in several natural tribes, very distinguishable from each other, although all residing in the watery element: but this element, so uniform in its general qualities, has yet several peculiar divisions; as in rivers, lakes, marshes, and seas. Its greatest distinction is that of salt water in its oceanic diffusions, and of fresh water in its terrestrial distributions; and some of the fish are appropriated to each of these. It is however a prevail-

* Dr. Thompson considers water to be a compound of one atom oxygen, and one atom hydrogen (Inorg. Chym. vol. i. p. 11, 56); or one volume of oxygen to two volumes of hydrogen; or if estimated by weight, eight of oxygen to one of hydrogen.—*Ib.* 99. The weight of a cubic inch of water is 252 grains, at the temperature of 60.—*Ib.* 103.

† The same intelligent chymist exhibits air as containing one-fifth of oxygen, and four-fifths of azotic gas, or nitrogen. "The mean of ten experiments, in which I removed the oxygen from common air by means of phosphorus, gave me a mixture of oxygen 20, azotic gas 80=100. This result was confirmed by decomposing common air by means of hydrogen gas."—Thomp. Inorg. Chym. p. 57. Ed. 1831.

‡ Every thing, even in the mineral world, appears to be a specific and determinate creation. "The opinion at present entertained by chymists in general is, that simple substances are aggregates of very minute particles, incapable of further diminution, and therefore called atoms."....
"They always combine with each other in definite proportions."....
"Matter is not infinitely divisible. Its ultimate particles consist of atoms incapable of any further division or diminution."....
"Notwithstanding their extreme minuteness, each of them has a specific weight."—Thomp. In. Ch. 3–9. His observations show that every substance is a definite composition of a fixed proportion of its constituent particles. For each substance to be, this proportion must not alter, as any other makes a different thing. The permanent continuance of each is therefore a lasting evidence of their intended, chosen, and appointed and specific creation.

ing opinion, that most, if not all, of the fresh water fish originated in the sea; and it is certain that many which are inhabitants of the ocean pass from it into the rivers of the land, to breed and deposite their young; and these show themselves to be capable of living alternately in each.*

By the Linnæan system, as revised by Gmelin, the whole fish world has been arranged into six principal orders, subdivided into several tribes.† Four of these are marked by the position of their ventral fins, and two by their gills.‡ This is an artificial classification, but it is a convenient one, and sufficiently answers its author's great end, of establishing a precise and applicable nomenclature, that could be generally adopted, and easily referred and added to.§

*A paper was read in April, 1793, at the Academy of Sciences at *Paris*, to show that *all* fishes had a marine origin, and that in the great irruption of the waters the fishes of the sea were *left* in rivers, lakes, and ponds; where such as could bear the transition and survived, propagated and left in them the *fresh water* species now known.—Lit. Gaz. No. 691.....It has been lately ascertained that fish will live in wine, but *not so long* as in water, yet much longer than in air.—Bull. Univ. 1830, p. 39.

†Order I. Apodal, without ventral fins. II. Jugular, with ventral fins *before* the pectoral ones. III. Thoracic, the ventral *under* the pectoral. IV. Abdominal, the same *behind* the pectoral. The gills of these have bony rays. The next two orders differ as to these. V. Branchiostegous, with gills destitute of bony rays. VI. Chondropterygious, with cartilaginous rays.—Linnæus Syst. Turton, 1, p. 701. These six orders comprehend 71 genera, of which 875 species are enumerated by Dr. Turton in his English edition of 1806. Others have since been added.

‡ The 1st order chiefly comprises the eel, gymnotus, and swordfish tribes, in 12 genera and 40 species. The 2d, the cod, haddock, whiting, ling, hake, and burbot, in 6 genera and 52 species. The 3d, the remora, John Doree, the kingfish, turbot, and other flat fish. Perch, stickleback, mackarel, and gurnard, in 21 genera and 425 species. The 4th, the salmon, trout, smelt, pike, mullet, herring, carp, and flyingfish, in 16 genera and 202 species. The 5th, the sunfish, the pipefish, the sucker, and several Indian, Egyptian, and Chinese ones, with others in the Pacific and American seas, in 10 genera and 84 species. The 6th, the sturgeon, shark, ray, and lamprey, in 7 genera and 70 species.—T. Linn. *ib.* ....Pliny had observed and enumerates 176 kinds.—L. 32. c. 11.....We have now nearly 900 species distinctly discriminated.

§ Willughby, following Aristotle, and improving upon him, distinguished the fish into three natural orders, the cetaceous, the cartilaginous, and the spinous.—Hist. Fish....This is a just division as far as it extends; but the minuteness, augmentation, and accuracy of modern knowledge require a larger arrangement, and more precise discriminations.

But besides all the tribes which Linnæus places under his order of fish, the inhabitants of the waters include also the crustaceous and testaceous genera, and the mollusca; as also the seal and morse tribes, and that of the whales, or cetaceous fishes. The latter are specifically mentioned by Moses, in addition to his general notice of all that move in the waters:

> "And ELOHIM created great whales, and every living creature that moveth, which the waters brought forth abundantly, after their kind: and Elohim saw that it was good." *

The whales, or cetaceous fishes, are so distinguished in nature from the rest, by their analogies to land animals; by suckling their young at the breast; by having warm red blood; and by a heart with two auricles and two ventricles, to propel this essential fluid, and by other peculiar properties; that Linnæus has separated from his fish tribes, and classed them among his mammalia order, with quadrupeds, simia, and man.† It was therefore correct in Moses to give them a distinct specification.

Water differs from air in being 810 times heavier.‡ But sea-water, containing in it a solution of chloride of sodium, has still greater gravity.§ Fish have therefore, in all their motions, to force themselves through an element that is nearly 900 times heavier, and, as such, more resisting and re-

* Gen. ch. 1. ver. 21.

† They have two teats; are gravid nine or ten months; bring forth usually one, rarely two young. They have spiracles on the forepart of the scull and pectoral fins, but no ventral or anal ones. The nostrils are flexuous, and on the forepart of the head.—Linn. Syst. i. p. 127.... The balæna, or common whale, suckles its young, and takes care of them with great affection. The eyes are a little larger than those of an ox. It has ears. Though so large, it is very shy and timid. The tongue of one kind resembles that of an ox in figure.—Kerr's Linnæus, p. 357, 358.... They breathe the air by real lungs. They have moveable eyelids and true bones, and can utter loud sounds, which no other fish can do.

‡ "At the temperature of 60°, and when the barometer stands at thirty inches, water is 810.734 times heavier than air."—Thomp. Inorg. Ch. i. p. 103.

§ This salt is "usually called common, or sea, or rock salt, and by the French chymists, muriate of soda. Vast beds of it exist in the new red sandstone formation: and *sea-water* contains about 3-5th per cent. of it, from which it is easily procured by evaporating that liquid."—Thomp. *ib.* vol. ii. 811.

pellent to them than the air is to birds. This greater gravity assists their suspension, but impedes their motivity; just as the vastly superior lightness of air facilitates the flight of birds, but gives no aid to their floating in it. Thus neither could exist in their respective elements without a peculiar provision adapted to each, in their muscular composition and nicely-suited powers.

The suspension of fishes in water,—their power of floating in it without sinking prone from its surface to the bottom, like a stone, arises from the great fact, that their bodies are so made as to be of an equilibrium of weight with it. All swimming animals are sustained by the water; and the principle of their being so is, that they have been created to be rather lighter than this fluid, or not heavier.* All fishes—all that inhabit the waters, except the crustaceous and testaceous animals, are of the same specific gravity as the fluid they live in;† and hence they float in it, and are sustained by it.‡ If we were to select one marking instance of the great exertion of intellect which must have accompanied creation, a more impressive one could scarcely be adduced than the adapted formation of every fish's body to the gravity of its watery abode. If all fishes had been of one weight, one effort of thought and contrivance would have been sufficient to have enabled all to swim; but every species of fish—almost every individual of each species—differs in its weight and size from each other; all, from the little tittlebat of our schoolboy walk and play-day, to the mighty and super-elephantic whale.§ A minute calculation must therefore have been made, in the original construction of each particular fish that so varies, in order that the amount of its component particles, and the disposition and expansion of its figured dimensions, might in every one be exactly such as to have the same specific weight with

* Borelli de Motu Anim. c. 23, p. 246, 249.

† Borelli, *ib.* 247.

‡ Galileo says he illustrated this by putting some salt water at the bottom of a vessel, and by introducing upon that a stratum of fresh water, and then placing a ball of wax adapted to the weight of the sea-water in the middle of the two. Whether this was pushed up or down, it always returned to the centre or top of the salt water, with which its gravity corresponded.—Gal. Mechan. Dial. p. 63.

§ "A whale, though, as I have heard, as big as ten elephants, can yet sustain itself in the water."—Galileo, p. 116.

that space of water which its bulk would occupy.* Unless this space and bulk were in every instance precisely adapted to each other, not one fish would swim. Yet all but the flat fish are ever floating and moving as they please, always suspended and supported, when they choose to be so. How surprisingly numerous must have been both the arithmetical and the mechanical computations!

But the creative skill and providing care were not confined to this equalization of space and bulk. Something more was requisite, and has been performed. The water itself differs in its gravity and circumstances. The sea-water is heavier than the lake, and river, and pond; and varies in itself, in this respect, from many causes. Yet, as Galileo remarked, the fish float and swim alike amid this diversity.† He found that this is accomplished by their being universally provided with an original function, by whose instrumentality they can and do themselves modify and adapt their own gravity to every temporary variation of the fluid they are in. This gift of their Maker's foresight is the little bladder in the middle of their body, which contains air, and which they can contract or expand as they please.‡ If the water become lighter than their bodies, they distend this vesicle and their own bulk, by rarefying or increasing the air within it; and thus maintain their equilibrium with it. If the fluid be heavier, which would throw them out of it, they empty and contract this organ accordingly, and so keep within it, or sink lower if they desire a greater depth. What a demonstration of the animal's volition and practical judgment, and of its Creator's adapting foresight!§

* "Have you not observed that fishes, as often as they choose, remain motionless under the water, so that they neither descend to the bottom nor rise to the top? This shows that their bodies are equal in gravity to the water. The bones are heavier, but their matter is lighter."—Galileo, p. 117.

† "Fishes preserve their equilibrium at their will, not only with one species of water, but also with those which notoriously differ; whether it be naturally or accidentally turbid or salt, which makes no small difference."—Galil. M. Dial. p. 62.

‡ "Yet they keep their equilibrium, so that they can remain in every place without the smallest motion; and they effect this, I think, by that instrument which nature has granted them for this purpose—a little bladder which they have within them, by emitting from it, according to their situation, some part of the air which it contains."—Galileo, p. 83.

§ Borelli has enlarged on the circumstances noticed by Galileo.

That it is this air-bladder which maintains and adapts their specific gravity is proved by the facts, that if this be burst they sink, and that the soles and flat fish, which live at the bottom of the water, have not this vesicle.* To be able to move through an element that resists their progress nearly 900 times more than the air obstructs our walking motions, their head has been so shaped as to divide the water with ease and safety. The body is made long and slender, to increase the facility, and is covered with an unctuous skin, or scales, which prevent all friction, and has that degree of sphericity which averts all ill effects from the immense pressure of the waters that are above it. They likewise have a combined power and flexibility in their muscular tail, which, by striking backwards against the water, gives them whatever projectility they desire, and continues it as long as they move it to and fro.† By this tail they impel themselves forward, as the bird does by its wings; and that it may have the constitutional and habitual ability of doing so, it is made to have the largest muscles of a fish's body.‡ Its necessary fulness and size for this purpose

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"Fishes are equal to the water in specific gravity. Hence they are better and easier sustained by it than we are by the hardness of the earth on which we tread. They have not the fatigue of supporting their own weight, as we have; need no feet like quadrupeds and fowls, and find no lassitude from standing. Hence they can be of a greater vastness than any land animal."—Borelli de Motu, p. 251.

"But such a uniformity between the gravity of the fish and the density of the water could not be long nor everywhere preserved, because fishes themselves become heavier from eating and lighter from their transpiration and discharges; and water, by the mixtures of salts, disturbance of its waves, the superambient cold and absence of the sun's rays, is condensed and made heavier—as the mingling of fresh water, subterraneous heat, and other causes, lessen its weight. Therefore, parental nature has bestowed on fish a mechanical artificium, by which every inequality of their specific weight can be easily reduced to the precise equilibrium required."—*Ib.* p. 252.

* Borelli, p. 252. A fish in a vessel was placed under an air-pump; its bladder burst as the air was exhausted; it sank immediately, and could not rise again, but from that time, crawling like a serpent, moved along the bottom.—*Ib.*

† "The instrument by which fishes swim is their tail. They are not impelled by their side fins. As often as their tail is brandished, they glide swiftly through the waters; its bending and vibrations are therefore the true causes of their movement."—Borelli, 257, 258... Ray remarks the same fact, and adds, that when they dart like an arrow from a bow, their fins are held close to their bodies, that they may not retard the motion."—Ray's Wisd. p. 151.

‡ Borelli, p. 257. "As it was thought that fish impelled themselves

cause the animal's centre of gravity to be in its back, which would therefore always turn its belly upwards, but for the counteracting force of its ventral fins. These are its provided instruments for keeping it in its right and regular position.* So admirably has the structure of this class of animated bodies been adapted to the artificial and compound medium in which they live. The water having been the first created, its appointed inhabitants were framed so as to suit exactly all its properties, and to derive from these a comfortable existence.† Even the faculty of seeing, which they have in common with other animals, has been specially modified from its general form into a peculiarity adapted to their native element.‡ Their mode of breathing, or of inspiring that air which is as essential to them as to every land animal, is also, with an admirable ingenuity, suited to the watery fluid they live in. This has always some air intermingled with its particles; and the winds and storms are always supplying it with new additions. No portion of the water is without air in its natural state; and fishes are so framed as to require no more than it thus contains, and are provided with gills to extract from it, or with interior functions to decompose from it, all that they require. This process has been made as easy to them as

by their fins, I cut off the fins of a living fish, and found it to be carried with its usual swiftness, in all directions, just as before."—*Ib.* 256.

* "To know this, I cut off the ventral fins of a living fish, and put it back into the pond. It then rolled from right to left like a drunken man, and could not keep an upright position."—Borelli, p. 257.... I am sorry to observe that he calls this a jucundum spectaculum. To him it might be an amusement; to the fish it could but be a species of sentient misery.

† "The bodies of all are the best contrived and suited to that place and business in the waters which is proper for them. Their bodies are clothed and guarded in the best manner with scales or shells, suitable to the place they are to reside in, the dangers they may be there exposed to, and the motion and business they have to perform. Their centre of gravity, of great consideration in that fluid element, is always placed in the fittest part of their body. The shape of their bodies, especially of the more swift, is the most commodious for making way through the waters, and *most agreeable to geometrical rules*."—Derham, Phys. Theol. L. 9. p. 412.

‡ "A protuberant eye would have been inconvenient for fishes, by hindering their motion in a medium so dense as water, or by brushing through its thickness would have been prejudiced. Therefore their cornea is flat. To make amends for this, and to suit the different refraction which water has from that of air, the wise Contriver has made the crystalline *spherical* in fishes, which in animals is lenticular and more flat."—Derham, Ph. Th. 413.

breathing to us. We merely expand and contract our chest by the action of the abdominal muscle of the diaphragm; and they have only to take in water with their mouths, and to eject it by the gills. Their interior functions separate and retain the accompanying air, and this is sufficient for their effective vitality.* They have no eyelids, neck, arms, legs, or external ear; but they have, like birds and cats, a nictitating membrane to draw over their eyes, when necessary; and they have an internal mechanism for hearing, specifically fitted to the medium they dwell in. They need, like ourselves, a certain portion of oxygen gas, and they have some unknown power of increasing this, according to their distance from the superincumbent atmosphere.† A very kind attention to their comfort appears in the circumstance that their natural temperature is made to be a little above that of the fluid they inhabit, so that there is never a greater difference than two or three degrees. This benevolent provision secures them from the sensation of cold, which they would otherwise have suffered from.‡

Fishes have been made to differ in size, according to their species; and they are of all sizes and weights, from the minnow to the whale. After the latter, the shark takes the lead in dimensions, as it is from one to four thousand pounds in mass, and sometimes thirty feet long.§ Others are of great bulk without much length.‖ But in their gen-

* Both Pliny (l. 9, c. 7) and Galen (l. 6, c. 9) show, "that they knew that fish respired by their gills;" though Aristotle, as the first remarks, had doubted it.

† Biot has found, from his experiments, that the proportion of oxygen in the air-bladder *increases* with the *depth* of the water in which the fish usually lives; from a small quantity up to 87 per cent.—Mem. d'Arcueil, vol. i. p. 252.

‡ Brussonet ascertained the temperature of a fish to be from ⅔ to ½ a degree higher than that of the water they lived in.—Mem. Ac. 1785, p. 191.....M. Despretz found a carp's to be 53° in water that was at that time 51°.4.—Ed. J. Sc. vol. iv. p. 185. Bostock's Phys. ii. p. 247.

§ Turt. Linnæus, vol. i. p. 914. "The white shark, carcharias, is the most dreadful and voracious of all animals—preys on every thing which comes in its way, even on its own tribe, and has been known to swallow a man whole."

‖ The oblong sunfish, which inhabits both the European and Mediterranean seas, though but half a foot in length, yet is of 400 or 500 lbs. weight. It appears like a fish cut off in the middle.—T. Linn. 802..... The rai aquila, chiefly in the Mediterranean, grows to 300 lbs.—p. 927..... The halibut, hippoglossus, in the European and Mediterranean seas, frequently reaches 400 lbs.; the flesh fat and coarse.—p. 762. The

eral nature, the other kinds are under a hundred pounds. Few reach fifty, and most are under twenty.* In length, there are not many above twenty feet.† Few attain ten feet.‡ The largest number are less than three; and most, not even half that size.

The ocean pervades and surrounds the whole globe, and is so permeable to that projectile force which the fishes have been constructed to exert without fatigue, that these animals have facilities for rambling as they like which no others possess. But, notwithstanding their native power, several prefer particular localities.§ Some‖ wander to great

glanis of the silurus class sometimes weighs 300 lbs., and its flesh is good.—p. 840.

* The turbot weighs sometimes 30 lbs., and the common eel and torpedo 20 lbs.; as the plaice will reach to 16 lbs. and the flounder to 6 lbs.—T. Linn. But these are not their ordinary sizes. Yet Captain Franklin found common trout in some of the lakes of the Cree Indians upwards of 60 lbs.; at Beaver Lake, 30 lbs. was no uncommon size.—Journ. p. 93.

† The sword grampus, orca, in the European and Atlantic seas, is 24 feet long and 12 feet broad. It attacks and fastens on whales, and often destroys them.—T. Linn. 130. The swordfish, gladius, in the European and Mediterranean seas, grows to 20 feet long, and is very active.—*Ib.* p. 716. The wolf-fish, lupus, a very ravenous and fierce fish in the northern seas, grows to 15 feet; the flesh is good, but not often eaten.—p. 713. The fine blue shark, that is in almost every sea, varies from 3 feet to 14 feet; fierce and rapacious, especially in warm climates.—p. 919. The scrofa scorpœna, a voracious fish, is from 3 to 4 yards long; its flesh is eaten in Italy.—p. 756.

‡ The thunny, thynnus, is from 2 to 10 feet.—p. 825. The salmon will grow to 6 feet.—p. 846. The pike varies from 1 foot to 8 feet, and grows very rapidly.—p. 860. The carp will also reach 4 feet.—p. 873. The common perch to 2, but the lucio-perca to 4 feet.—p. 810. The frog-fish, piscatorius, attains 7 feet.—p. 909. The spotted dogfish 4 feet.—p. 915. The beautiful kingfish on the coast of Normandy, is sometimes 3 feet long.—p. 760. The porpoise is from 5 to 8 feet, and the dolphin from 9 to 10.—p. 129. The salmon-trout seldom exceeds 2 feet.—p. 847. The ling reaches 7 feet, and the burbot 3 feet.—p. 730, 731.

§ Thus many keep in the seas about China and Japan; others in the Red Sea; several on the coast of India; others about Brazil; many on the West India islands; and some in the rivers of Egypt, and in those of other countries. Some are in the Adriatic; others in the Baltic; and many are peculiar to the Caspian. The Greenland and Arctic seas detain others in their proper climates. The goldfish were in the rivers of China and Japan till brought purposely from them.

‖ The voracious sea-fox, the vulpes, seven feet long, is of this kind. His home is the Mediterranean, but he often wanders into the British seas.—T. Linn. 918. . . . The sea-pike, belone, which usually resides in the depths of the ocean, rises and migrates annually towards the coasts, always preceding the mackerel.—*Ib.* 860. So the ductor gasteosteous is the constant attendant on the shark, and always goes before it.—p. 899.

distances. Others are confined to inland seas and lakes.* But the greater part move freely and variously through all the divisions of the oceanic diffusion, and especially those which sail in large shoals, or which seek the rivers or the shore to prepare and deposite their spawn.

Their reproductive system, analogous to that of plants by seeds, is oviparous almost in all; although some species, instead of eggs, bring forth their young alive.† But the great majority lay their oval spawn; and some with a fecundity that equals the most marvellous abundance of vegetable sporules or semina.‡ There is something in the statements of Leuwenhoek, which at times startles the mind into an unwilling incredulity, or at least create in it a doubt, whether imagination has not been more busy than patient and cautious judgment. His estimation that the eggs in a single codfish exceed nine millions excites this cautious hesitation. It is therefore a relief to find that another student of nature has endeavoured to ascertain the truth by a later and careful examination. M. Harmer's investigations have moderated the amount, but display a productiveness in those fishes which he inspected that anterior to such investigations we should not have anticipated.§

It is the appointed law with many, that although among

* Thus one species of the sparus, the galilæus, inhabits the lake of Genesareth, in Galilee.—T. Linn. p. 789.

† The sharks bring forth their young alive, and more than one at a time. They come enclosed in a square horny case, with filaments, which are twisted round corallines or sea-weeds, to keep them steady.—T. Linn. 914. . . . The viviparous blenny, 15 inches long, produces alive 300 or 400 young ones at a time. It inhabits the depths of the European seas.—p. 736. . . . The rai is also viviparous, but with one only; and the young rai is in a horny case, somewhat like the sharks.—p. 925. . . . Eels also reproduce alive.—707.

‡ The Chinese have taken a fancy to hatch fish under fowls. For this purpose they collect from rivers and ponds the gelatinous matter which contains the eggs of fish, put it into vessels, and sell it to the proprietors of ponds. When the hatching season arrives, a fowl's egg is emptied of its usual contents, and this gelatinous matter is put in. The entrance is hermetically sealed, and it is put under a hen. After some days the egg is opened, and placed in a vessel of water heated by the sun. This is kept in his rays until the little fish become strong enough to bear the external temperature.—Bull. Univ. 1829, p. 82.

§ His papers are published in the Philosophical Transactions of the Royal Society for 1767, vol. lvii., p. 280. His method was to weigh the roe of the fish with accuracy, and then to count the eggs in a certain number of grains. The following are some of the facts which he thus explored:—

the general inhabitants of the sea, yet that they should be born in river-water; and that for this purpose their maternal parents should travel from the ocean to the fluvial streams of the land; and, forcing their way in opposition to the descending currents, glide upwards to such places as they select to be proper beds for their future progeny. The salmon is a remarkable instance of this selecting and persevering instinct.* The salmon-trout, smelt, and shad, and several others, perform similar journeys.† Others sail in vast shoals to the coasts of different countries for the same purpose of depositing their eggs along the suitable banks and shores.‡ All are solicitous and careful to discharge them in the safest places that will promote their future vivification;§ but here their parental instinct ends:

	Eggs.		Eggs.
Carp, ... one had	101,200	.... a larger	203,109
Codfish	3,686,760	—	
Flounder, one	133,407	.... a larger	225,568
Ditto, weighing 6¾ oz. ..	351,026	—	
Ditto, 24 oz.	1,357,400	—	
Herring, one	32,663	.... a larger	21,285
Lobster, one of 14½ oz.	7,227	.... one of 36 oz.	21,690
Mackerel, 20 oz.	454,961	.... a smaller	546,681
Perch	28,323	.... a smaller	20,562
Prawn	3,806	.... a smaller	3,479
Roach	81,586	.... a smaller	113,841
Shrimp	3,057	.... twice larger	6,807
Smelt	29,925	.... a smaller	30,991
Sole	100,362	.... a smaller	28,772
Tench	280,087	.... a smaller	350,482

Dr. Thompson's Hist. Roy. Soc. p. 81.

* "The salmons move into rivers once a year, in large shoals, to deposite their spawn on beds of gravel. For this purpose they will surmount any difficulties. They ascend often above a hundred miles, forcing their way against the most rapid streams; and where an obstacle impedes them will spring to a height of seven or eight feet to pass over it. After completing their purpose, they return to the sea poor and lean."—T. Linn. 845, 846.

† T. Linn. p. 847, 851–853, 869, 911; the lamprey, 931; flounder, 763.

‡ The herring, the sprat, the anchovy, the thunny, the haddock, the whiting, the ling, the coalfish, the pilchard, the mackerel, the stickleback, and the whiteback, all come in shoals to our coasts, or appear in masses in our rivers.

§ The upper and shallower parts of rivers, where the eggs may receive the warming rays of the sun as they act on the earthy bottom, are chosen by several; so the shallow banks and sands of the shores, and wherever that degree of tepifying heat will occur which is requisite for hatching the egg into its bodily development. The living principle needs the aid of heat for the growth of its material structure, but some seek a diminution of light: thus the red char selects the borders where trees cast a shade.—*Ib.* p. 849.

after this care they leave them to the other agencies of nature to mature. But the young fry need no further attention. At the proper time, varying in each species, they emerge from their oval abode,* and immediately move about with great agility, and apparently in the full possession of their appointed faculties. Their wants are so few, and the supply so immediate, that as soon as they come into sentient being they have about them all that they require. They need no parental nutrition. A mother, in their element, could not do more for them than to provide a proper birthplace for them; and every maternal fish performs this office by moving to the right stations with the instinctive accuracy which resembles selecting judgment.†

Their food is that which their element contains, and of which there is always abundance within the power of their easy attainment. Some subsist only on plants of various sorts, which grow in the sea or on its shores.‡ Many more

* The salmon continues in the egg four months; the carp only three weeks. The spawning time varies. Trouts are full about Christmas; perch in February; pikes in March; carp and tench in May.—Tull. in Phil. Tr. vol. xlviii. This gentleman found the abstraction of the ovaries to increase the size of the fish; but it is a cruel operation.

† Summer is the most usual time for their productive process. In June, the ling approach the shore, and deposite their ova in muddy bottoms, and among sea-weed, near the mouths of rivers.—P. 243. . . . In May or June, the shad and the thunny spawn.—T. L. 825. Several ascend the rivers in spring, and remain several weeks or months before they return towards the coast in winter, as the anchovy, from December to March.—869. The haddock appears in vast shoals on the Yorkshire coast about Christmas.—725. The codfish lays its innumerable eggs in the spring, under the stones it finds; the whiting trout deposites its spawn among rocks in a southerly shore.—726. . . . The plaice lays its ova among the rocks and marine plants, about March.—Bing. 253. . . . The fry of crabs, and of other crustaceous species, is deposited at the bottom of the waters; but it rises and floats on the surface in warm and rainy weather, where it is vivified by the sun's heat. When the cold comes, it sinks to the bottom, and the young ones bury themselves in the bottom of the sea or among the fuci and algæ of the sub-marine rocks.—Donovan, F. M.

‡ The unicornis chætodon, about an ell long, which is numerous on the Arabian coasts, feeds on herbs.—T. Linn. 781. Two species of the scarus, also in the same locality—one, the rivulatus, a yard long; the other, stellatus, only half a foot, which lives among the coral banks. —790. The sciena studens also, which is likewise an Arabian fish.—807. . . . . Both carp and tench may be reared and fed like capons, with brewing grains, malt coarsely ground, or any grain boiled, especially pease. Encyc. Brit. 259. . . . . Mackerel (scomber) are also herb-eaters. They are particularly fond of the sea-plant called the narrow-leaved sea wrack, which grows in great abundance on the English

feed on herbs, with the addition of worms and insects.* Some also use a kind of soft and fat earth.† A larger number seek their sustenance from worms and insects without the vegetable mixture.‡ Several live on crabs and shellfish.§ But the great majority of the fish nation sub-

coast and other places. . . . This plant, the "zostera, is a common material for packing, and for stuffing cottagers' cushions."—Lind. Nat. B. 290.

* The salmo wartmannus, in the Alpine lakes of Switzerland, 17 inches long, a very fertile animal, feeds on worms, insects, herbs, and sort of sponge.—T. L. 855. . . . The latus cyprinus, which inhabits in great shoals the lakes and still rivers of Northern Europe, about a pound weight, very prolific, also feeds on worms and herbs.—887. . . . So the tench, roach, and gudgeon, and several others; some also taking young fry and smaller fish. The dobula takes likewise the leeches it finds.—p. 881.

† The carp and bream swallow earth. So the prickly ophidium, the fossilis cobitus, and orfus. The carassius uses mud for its digestive purposes.—T. Linn. 872, 876, 837, 882, 885, 714. . . . The common codfish, for some benefit to itself, will often swallow stones and hard substances.—726. . . . The beautiful fish of the rivers to the north of the Great Slave Lake, towards the arctic regions, named backs graylings, corogonas signifer, described by Dr. Richardson, has "its stomach generally filled with gravel or black earth."—Frankl. Voy. p. 713.

‡ As the shad, dace, and dab.—p. 869, 881, 763. . . . The common eel feeds on snails as well as worms; and at night will quit its watery element, and wander along meadows in search of them.—p. 707. . . . The herrings, in their season of shoaling, feed largely, as they float, on that insect which at this time covers the sea with a kind of scum, and which Rondoletius fully describes, and calls the sea caterpillar. The red char alpinus, in the northern mountain lakes, feeds on larvæ of the gnat kind.—T. Linn. 849. . . . The chætodon rostratus, an Indian fish, living chiefly near the shore, or the mouths of rivers, feeds on the insects which fly near the surface of the water. It catches them by ejecting water at them from its tubular snout, which strikes them down within its reach. —T. Linn. 770. . . . The sparus insidiator, also in the Indian seas, has the same habit, and the same success from its projectile dexterity.—p. 785. . . . The zeus insidiator, in the fresh waters of India, obtains insects in a similar way. It sucks water into its gills, and casts it upwards suddenly from its mouth, so as to wet their wings, and disable them from immediate flight, till it can take them.—p. 759.

§ The sea monster, chimæra, in the deeps of the Atlantic and North Seas, feeds on crabs, molluscæ, and testaceous animals.—p. 913. . . . . The monoceros balistes, in the seas of Asia and South America, from one to three feet long, seeks young crabs and polypi.—p. 898. . . . . The aculeatus, in the Red Sea, lives on crabs. The dragonet, callionymus, feeds on echini and starfish.—722. . . . . The blenny lives chiefly on crabs.—736. . . . . The wolf-fish, which feeds on the lesser shellfish, grinds them to pieces with its teeth, and swallows the shelly matter as well as the animal.—p. 713. . . . . The conger eel takes the crabs in their soft state.—p. 708. . . . . The teira, in the Arabian and Indian seas, feeds on the corals and testaceous animals.—729. . . . . The sparus auratus lives chiefly on shellfish, which it breaks and macerates with its strong teeth

sist on each other. Some are so indiscriminatingly voracious as to consume those of their own tribe which they can master or meet with.* A few make sea-birds a part of their nutriment.† The spawn and fry of other species are the food of many; and some will consume the animal dead bodies they find.‡

There is something splenetic in many of our writers, when they dissert on fishes. Our pleasing essayist, poet, dramatist, and novelist, but too hasty and careless writer on Animated Nature, speaks of them with much ill-humour and misconception; and, with inattention to their general habits and nature, characterizes all their thousand species by the particular appetites of a few.§ Others follow his track of misrepresentation.‖ Although the worthy doctor began his account with justly declaring that "millions reside in their extensive and undiscovered abode, whose manners are a secret to us, and whose very form is unknown;"

before it passes them into its stomach.—784.... The tiger shark, of India, 15 feet long, feeds on the testaceous and crustaceous animals of the sea.—Pennant, Ind. Zool. p. 55.

* Not only the shark and pike have this habit, but the common cod will also prey upon its own species.—T. Linn. 726. The trout likewise. —847. One species of perch, lucioperca.—810.

† As the scrofa scorpæna, in the Atlantic, Mediterranean, and North Seas.—Ib. 756.... The salmo rhombœus, of Surinam, is said to bite off the legs of the ducks that come to the waters to seek the first fish they can master.—p. 857.... But this is only "diamond cut diamond."

‡ The conger eel has this taste.—p. 708. So the barbel and the gudgeon, 873, 874; the surmullet, 820; the lamprey, 931. The shark and pike take every thing. The hyrpuris coryphæna is as voracious; from four to five feet long; it follows ships, and greedily devours what is thrown overboard.—p. 741.

§ Thus, "their rapacity seems insatiable."...."Fish are of all other animals, the most voracious and insatiable."...."The life of a fish, from the smallest to the greatest, is but one scene of hostility, violence, and evasion."...."Such is the general picture of these heedless and hungry creatures."—Golds. N. Hist. vol. iii. p. 419, 421, 431,..."*All* fish live upon each other."—p. 540. "All fish are enemies one to another."—p. 544. Both these assertions are notoriously unfounded; and the doctor repeatedly contradicts them, without perceiving it, by several facts that he states of their particular classes.

‖ So Mr. Wood, in his Zoography, "In the inhabitants of the waters we look in vain for any thing beyond the mere gratification of voracious appetite."—vol. ii. p. 115. "The whole race of fishes seem to be impelled by a voracious appetite; they are constantly in action, and perpetually at war. They mutually plunder and devour each other without remorse or moderation. So great is their mutual destruction, that their element would in time cease to be replenished, but that their fecundity exceeds their natural impatience to devour each other"—p. 121.

and although even of those whom "the curiosity and wants of mankind have drawn from their depths," he states that "their pursuits, migrations, societies, antipathies, and pleasures are all hidden in the turbulent element that protects them;"* yet this proper recollection of our very superficial knowledge of this interesting class of creatures has not saved them from his promiscuous invectives. But many of his remarks on natural history show very hasty and imperfect reasoning: and to prevent your mind from being misled into erroneous notions concerning them, a few circumstances shall be submitted to your consideration in the next Letter, which may incline you to believe that fishes are not such a despicable and disgraceful anomaly in creation as they appear to be in these discoloured and exaggerated caricatures. You will find, that while as a whole they greatly resemble the other departments of the animal kingdom, both in faculties and qualities, they seem to possess some advantages which might make them even happier, but that individual comfort in all the races of sentient beings has been most carefully and universally provided for. This is the law of the formation of all, though the contingencies arising from the external action of other things occasionally and unavoidably cause among them, as among the other classes of nature, disturbing exceptions. We must be wholly insulated from every other being to be entirely free from any exterior agency; yet, who would desire to be a lone hermit in creation, to avoid the pains which fellow-creatures sometimes produce?†

* Golds. p. 411, 412.

† The growth of fish is very gradual in some. A carp is, in the first year, the size of a willow-leaf; in the next, four inches; in the three following years they grow one inch in each; and after five, they increase in the next three years according to the nature of their pond.—*Ib.* 539.

As to sea-fish, fishermen allege that they must be six years old before they are of a fit size for the table. A mackerel in the first year is of the size of a finger, which it doubles in the second; in the two next years it enlarges, but without melt or roe. Between five and six, it is of the length we eat. The turbot and barbel are in the first year like a crown-piece; in the second, will cover the palm of the hand, and between five and six, are fit to be dressed.—Duhamel, Tr. Peches. p. 100.

LETTER IX.

The Forms and Colours of Fishes—Their general Character—Voices of some—Their Serenity and habitual Comfort.

The fishes which are most abundant and most frequent in our sight have pleasing forms. Some are more picturesque than beautiful. Occasionally we find grotesque ones;* and a few with that structure and look which are called deformity.† But what we deem ugliness in nature is very often rather contrast and peculiarity, than absolute defect. We know nothing of beauty and elegance but from the figures, colours, movements, arrangements, and appearances of created things. These are purposely so constructed and diversified by their great Author; and there is such a profusion of what excites feelings of pleasure and admiration within us, that we consider as inferior, and we depreciate or dislike, whatever is of a dissimilar or opposite nature. If the more attractive objects had not been in existence, and known to us, we should have admired and valued what now, from the comparison, is considered deformity, and becomes our aversion.

But, exclusive of figure, the largest number of the fish tribes are very agreeable objects to our sight; and many eminently beautiful in their colours, and in the general appearance of their neat and glossy skin and scales. Though dwelling in a watery medium, yet the marvellous light,

* The sea bat of Edwards, and the horned fish of Willughby, are of this sort. The latter has no spinal or other bone, but is covered with a thick and strong horney case. The Brazilian guaperva, which may be seen in the "Planches Enluminées," has a strange figure, of a dull red colour. The sea unicorn, monodon monoceros, seventeen feet long, with a horn resembling ivory, protruding seventeen feet farther, and having a skin like polished marble, is a picturesque animal, not unpleasing.

† The frogfish, or common angler, piscatorius lophius, called also the sea devil, resembles the tadpole of a frog or toad, but enlarged to the size of four or five feet. The hammer-headed shark and the sea porcupine may be deemed ugly, or only grotesque, according as our imagination inclines to estimate them.

from whose component rays all beauty of colour and splendour proceed, often richly combines its adorning beams in their exterior surface; and emanates from them, by some inexplicable process, its softest and sweetest brilliance. Our commonest fish are often highly pleasing.* Several have a golden hue or spots, difficult to account for;† and many, a silvery gloss, as though particles of these two metals were diffused among their skin.‡ Others display a fine tinge of blue.§ Some, very pleasing tints of green.‖

* "There is not one that exceeds the mackerel in the brilliancy of its colours, or in the elegance of its shape. The fine deep blue upon the back is crossed by many black streaks, and accompanied by a tinge of green, which varies as the fish changes its position. The bright silver colour of the abdomen, and the varying tinge of gold green which runs along the sides, are eminently beautiful in this species; but are only to be seen to perfection when it is first taken out of the water, as death impairs the colours."—Wood's Zoography, vol. ii. p. 170.

† The hippuris coryphæna, six feet long, in the Mediterranean, is sea-green, spotted with orange. When alive in the water, it has a fine golden splendour, which vanishes when dead.—p. 741. The plumieri, of the same genus, is golden on the sides and silvery beneath; the upper part brown, with blue curved lines.—p. 742. The auratus scomber of Japan is a fine gold colour.—p. 825. The Arabian speciosus, of the same genus, is a pale golden.—p. 826.....The paru of South America, is a gold colour on his back, with a silvery belly.—p. 716. The John Dorée has the name from its resplendency; it seems as if it were gilt.—p. 760. The auratus sparus has a semilunar gold spot between its eyes, which occasions it to be called "gilt-head."—p. 783.

‡ The fasciolata coryphæna is a beautiful fish, milk white, with a silvery hue. The velifera, near Southern India, is as silvery, as to colour. The rupertus, round Greenland, has a silvery body.—T. Linn. p. 743, 744.....The polynemus, of the Nile, is covered with scales of a brilliant silver colour, like spangles lying close together.—Shaw, Nat. Mis..... The Arabian ferdau scomber is silvery, with golden dots at the sides; another is shining silvery without the spots.—p. 826. The body of the trichiurus is entirely silvery.—p. 712. The two species of the centrogastor are silvery.—p. 829. The Indian kurtus appears as if covered with silver scales.—p. 737. The striped surmullet has silvery scales, streaked with tawney.—p. 830. The stylophorus has a rich silvery body.—p. 716. Many others display the hue of this pleasing metal. The air bladder of the sphyræna argentina appears as if it were covered with silver leaf It is used in manufacturing artificial pearls.—p. 863.

§ The glaucus squalus displays a fine blue in the upper part of his long body, and a silvery white below.—T. Linn. 919. It is peculiar to the shark to shine by night. An Arabian species of the scomber is of a shining pale blue body, with golden spots at the sides.—825. The thunny is a steel blue above, and silvery in his body.—825. The perca punctulata is dotted with blue.—815.

‖ The collas scomber, of Sardinia, has a body varied with fine green and blue.—824. The perca volgensis is a green gold colour.—816. The acarus viridis is green.—792. The kingfish, luna, off the coast of Nor-

Delicate gradations or diffusions of other colours make other species interesting to us.* The effect of the whole is, that the general appearance of the fish creation, in their forms, colours, brilliancy, gliding movement, rapid and changeful activity, and universal animation and vigour, excites sentiments of pleasure and admiration in every fair and free mind that beholds them, in their free and spontaneous motions, in their native element. To us—with the exception of a few, principally the shark tribe—they are wholly inoffensive, as even sharks are in some places. None of them leave their element to attack us. Not many, even in their own domain, would molest us; but all, even the most hostile, remain there, helpless and indefensible against our power, however great their magnitude may be. All are at our mercy. The fiercest cannot long resist our means of annoyance.† We kill and take what we please. None can either master or escape us. The Divine command,

mandy, is the most rich and splendid in its colour of all European fish; its body is beautifully green and red, or purple, with oval white spots.—760. The angelfish and lunulated gilt head have a pleasing green tint. In the hirundo trigla, its pectoral fins are a pale green, edged and spotted with a rich blue, while its body is, above, a greenish brown, and below silvery, with sides tinged with red.—833. The labrus viridis is green, with a blue line on each side.....The L. pavo's body is varied with green, blue, and blood-red—both Mediterranean fishes.—p. 797, 794....The nox viridis, of Carolina, is green.—859.

* The labrus trimaculatus is red, with three large spots; so is the L. variegatus, with four olive stripes and four blue ones.—800. Others display the red colour. The hamrur sciæna, red with a copper gloss. The S. bohar, reddish, with white dots; and the S. rubra, dusky red, and beneath white.—804, 805. The perca miniata is scarlet, with blue dots.—816. The cuculus trigla is red above, dotted with black, and silvery beneath.—833. The surmullet, when deprived of his scales, is found to have a red body. Nothing is more beautiful than the colour of this fish when dying. It was esteemed such a delicacy by the Romans, that it was often bought for its weight in pure silver.—p. 830. Of other colours, the labrus coquus is purple and dark blue above, and yellow below. The L. mixtus is variegated with yellow and blue. The L. cynedus is a pale yellow, with a purple back. The L. varius is diversified with purple, green, blue, and black.—803. The sciena fulvi flammus is yellowish, with golden stripes; and the L. kasmira yellowish, with four large blue stripes on each side.—p. 804. Many pleasing combinations of colour might be thus enumerated.

† No fish seems fiercer or more dangerous than a shark, yet a single negro, with only a sharp knife, will sometimes voluntarily attack it. The animal must turn on its side to give the fatal gripe, and while he is making this motion, the courageous black dives beneath and stabs him in his belly, repeating the blows till the creature becomes his victim.—Golds. Nat. Hist. vol. iii. p. 475.

that man "should have dominion over the fish of the sea," has been unceasingly fulfilled in all parts of the world and in every generation, both of their races and of our own.*

The general character of fish is not that of voracity and hostility. It is gentleness, harmlessness, sociality, and animation. They are peaceful animals; happy in themselves, and for the most part harmonizing together, without any general display of savage cruelty or malignant passions. Such as are appointed to be the food of others die in that way, and are sought and taken for that purpose, when the appetite actuates, but no further. But they cannot be justly stigmatized as voracious for this habit, more than ourselves for taking and eating them and cattle, sheep, fowls, game, venison, and other living creatures. We are carnivorous, but not voracious. We kill and cook the animals we feed on, but we have no malice, or ill-will, or hostility in such action or diet, any more than in plucking the apple, grinding the corn, or boiling the potato. It is therefore unjust to impute peculiar voracity and destructiveness to these tribes, because some feed on smaller fish, and others on the molluscæ, worms, and insects that they find. These latter animals appear to be as specially provided for such as use them, as slugs and caterpillars are for birds, and grass for cattle; for, at particular seasons, the ocean is made to swarm with them, for no other visible purpose than that the fish may derive nutrition from them.† The molluscæ, which supply so many of the natives of the sea with their subsistence, are therefore endowed with a power of multiplication which, as in several other cases, astonishes us by its amount.‡ It is the abun-

* Even the shark seems not habitually or willingly to attack the human race; for Captain Portlock mentions that he saw five or six large sharks swimming about the ship at a time when a hundred Indians, male and female, were in the water: they never offered to molest these people, though they seized greedily the bait thrown to them by the sailors; nor did the islanders show any fear at the presence of the sharks.—Portl. and Dixon's Voy. to South Seas. Wood, p. 225.

† Mr. Thompson has brought to our notice the genus mysis, one of the small crustaceous tribes, scarcely an inch in length. Though hitherto almost unknown to naturalists, it is in extreme abundance in the north seas. They appear in spring and summer in masses so immense as to cover the ocean to a great extent.—They are *then* the chief food to the large whales and other fish.—Thomps. Zoolog. Researches, No. 1, 1828.

‡ "The fecundity of these moliusques acephales surpasses all belief. Pfeiffer found, by an artificial calculation, 400,000 young coquilles con-

dance of these petty invertebrated animals, of various species, so sedulously provided for the nutriment of the fish, which constitutes that luminous appearance or phosphorescence of the sea which so often surprises and delights the mariner on his watch in his nightly navigation.* If some species of fish are always eating, which is not by any means an authenticated fact, they would but resemble the graminivorous quadrupeds, who pass their day in browsing, and in resting rumination; neither can be fitly branded as voracious in such perpetual mastication; for what animal is milder or more inoffensive than the tranquil, the ever-eating cow, who takes 100 lbs. of grass in a day.

But there are some facts which indicate that the fish have been much misconceived in this respect, and that, however it may be with some particular classes, or at particular seasons, the far greater number take less food, and live with pleasure, and apparently from choice, longer without any ascertainable quantity of it, than any other tribes of animals that we know of. "The gold and silver-fish in our vases seem never to want any food. They are often seen for months without any apparent nourishment."† Even the pike, which has been so much branded as a devouring glutton, fattens on total abstinence.‡ The salmon, although it comes in such multitudes from the ocean into

tained between the upper part, while *new* eggs were developing themselves in the ovary."—Feruss. Bull. Univ. 1827, p. 416.

* "The sea then appears as if on fire. The drops of water thrown from one part to another are like flame. The light is not only *intense*, but of all varieties of colour, red, blue, gold, and silver. It is caused by many animals, of very different sizes and classes, which come to the surface when the sea is in motion; and which shine most strongly when they themselves are most agitated. They belong to different divisions of the invertebrated class. They are sometimes to the depth of five fathoms."

Langstaff, in 1810, as he passed from New-Holland to China, found them of the size of a pin's head, in little chains three inches long; but in such numbers that the ocean seemed a sea of luminous milk.

Mr. Thompson observed another kind, near Gibraltar, of the same pin's head size, of the medusa species. These were so numerous, that the sea looked like melted silver. Mr. Thompson particularizes other genera of these phosphorescent crustaceous animals, in his curious Zoological Researches, No. 2, 1829.

† Goldsmith, vol. iii. p. 420.

‡ "The pike, the most voracious of fishes, will live in a pond where there is none but himself; and, what is more extraordinary, will be often found *to thrive* there."—Goldsm. p. 421.

the rivers, yet, when opened, is never found to have any nutritive substance in its stomach;* an evidence of their taking none in that period of their existence—for the herrings, when they shoal, are found, on being opened, to have fed largely on the sea-caterpillar in their voyage.† The lamprey tribe are confessedly small, or no eaters.‡ Many facts of this sort will be recollected by the intelligent naturalist, which will lead him to inquire whether the great majority of the finny world do not, for the larger part of their existence, content themselves with the nutrition they extract from water alone, without any additional substance. At some seasons of the year, as they approach the time of spawning, or to recruit their wasted bodies afterward, many feed on the animal substances to which their associated instinct leads them; but this can only be for an interval, in all those who live on the crustacea, molluscs, sea insects, caterpillars, or spawn—for one obvious reason, —that many of these are temporary productions, which appear only at a particular part of every year, and once consumed, are not to be had again until the returning season in the next year reproduces a new supply. The exuberant mackerel tribe, that seek in their shoaling the sea plant on the coasts in our neighbourhood, find that only in the beginning of summer. The probability therefore is, that instead of being, as they are called, an ever-eating omnivorous race, the fish tribes are the smallest consumers of food, either vegetable or animal, of all the classes of animated nature.§ That the pike, who bears

* "All fishermen agree that they never find any food in the stomach of these fish."—Wood's Zoog. p. 178.

† Rondoletius rightly infers their use of this food, from the quantity of it found in all their stomachs.

‡ Dr. Goldsmith admits its "simplicity of appetite. In fact, the lamprey's food is either slime and water, or such small water insects as are scarce perceivable. When it comes up into our rivers, it is hardly perceived to devour any thing."—p. 493.

§ The whale is a specimen of this. Although so vast in bulk, he feeds on little or nothing. "How, then, do they subsist, and grow so fat? A small insect which is seen floating in these seas, and which Linnæus terms the medusa, is sufficient for this supply." "This is the simple food of the great Greenland whale."—Goldsm. p. 445..... But this supply can only be for that portion of the year when these little animals appear. For the other months the whale must be without this food; and this seems to be the fact—for "the stomach and intestines of all these animals, when opened, seldom have any thing in them, except a soft

the distinction of being the most voracious of devourers, can yet live for months, and be hearty, without devouring any thing, is an indication to us that the natural constitution of fish is to live without any food but the element they swim in; and that their requiring it is from some extraneous impulse, and for some specific purpose, which they accomplish by taking the temporary gratification. If food were essential to their comfortable vitality, they could not subsist without it. The desire and use of it may therefore be inferred to be an occasional appetite, for an appointed end, which it accomplishes; and not a general habit or necessity, as it is with us and quadrupeds, for the support of our bodily existence.* This view of their mode of feeding is at least worthy of some further investigation.

The mild and harmless character of the fish class of being, in its general prevalence, is impressively exhibited

unctuous substance of a brownish colour."—*Ib.* 446.... Thus the whale although the largest and strongest of all known animals, is the smallest eater.

* A few facts as to the feeding of fish on each other will give us a fuller view of the habits of some in this respect. Some SOLES have been found with roes of shellfish in their bellies, though their usual food is the spawn and young of other fish, and though they have no apparatus in their mouth for masticating shells.—Bingley, iii. p. 254..... Some of these were found within them in a state of solution, as if some chymical action of the intestines had dissolved them. TURBOTS devour the smaller kinds of fish, but invariably refuse all that are not living.—p. 251.....Bloet found several young plaice and gurnards in the stomach of a LING. In the stomachs of WHITINGS both sprats and young herrings are often found.—Bingl. 241.....The HADDOCK has been found to become fat on herrings.—*Ib.*.... The MACKEREL make great havoc among a shoal of herrings, when they get among them.—262.....The red surmullet feeds eagerly on crustaceous animals.—266.....Water snails are found in the stomach of the grayling.—279.....The dogfish at times devours large numbers of the haddock and cod, and at others seems indifferent to them.—316. Remains of the dogfish have been found in the stomach of the frogfish.

That several fish consume others is certain. But the points which require to be ascertained are, whether the eating appetite of fish is not an impulse of particular seasons for particular purposes; and whether for some portion of the year they do not subsist without food; whether even the carnivorous are not harmless and tranquil, except at the stimulating period; and whether their desire for food is not simultaneous with the supply, and as temporary as that frequently is; and, what is the proportion, in number as well as species, of those who feed on other fish, to the tribes that use only vegetables, or insects, or the crustaceous and testaceous classes. The correct answers to these questions would probably reduce the alleged voracity of fishes to a much more moderate estimation than is now entertained by many.

by most of its largest tribes. The great Greenland whale "pursues no other animal; leads an inoffensive life; and is harmless in proportion to its strength to do mischief." The massy sturgeon is of the same gentle nature.* The formidable narwhal, or sea unicorn, with all its size and powerful weapon of offence, displays the same disposition.† The Oronooko manati, which has been found so huge in bulk that twenty-seven men could not draw it out of the water, and the others of this tribe, of which some are twenty-eight feet long, and weigh eight thousand pounds, are likewise gentle and peaceable animals.‡ These mightier chiefs of the finny nation are the true representatives of its general character. All are for the most part the same mild, playful, animated, and unoffending beings; and have been so designed and organized, habited and stationed, as to be continually of this placid temperament.

But the ocean contains some of a different humour, as the woods and mountains have the wolf and the tiger. A warring and vindictive temper appears at times in the Indian swordfish, with a strength which resembles the impulsion

* "The sturgeon, with a form as terrible and a body as large as the shark, is yet harmless. Incapable and unwilling to injure others, it flies from the smallest fishes."—Goldsm. 495. "It is a harmless fish, and no way voracious. It never attempts to seize any of the finny tribe, but lives by rooting at the bottom of the sea, where it makes insects and sea-plants its whole subsistence."—*Ib.* 497. This great fish must therefore be a very slender feeder. Hence has arisen the German proverb, "which is applied to a man extremely temperate, when they say he is as moderate as a sturgeon."—*Ib.* 498. Yet, "in the water, he is one of the strongest fishes that swims."—*Ib.* 499.... The sturgeon ought to be as numerous as he is powerful; for Leuwenhoek professes to have reckoned 150,000 millions of eggs in a single roe. This seems extravagance. Yet Catesby declares that the female frequently contains a bushel of spawn. Either estimate is surprising.

† "In all the variety of weapons with which Nature has armed her various tribes, there is not one so large or so formidable as this. Yet, notwithstanding this, and its amazing strength and unmatchable celerity, the narwhal is one of the most harmless and peaceable inhabitants of the ocean. It is seen constantly and inoffensively sporting among the other great monsters of the deep, no way attempting to injure them, but pleased in their company."—Goldsm. 453.... It is as small an eater as the whale. "Both want teeth for chewing, and are obliged to live on insects."—*Ib.*

‡ Pennant, Buffon, and Dr. Shaw describe them as tame, inoffensive creatures, who feed on aquatic plants and such herbage as grows close to the water, which they never quit.

of an elephant.* The grampus, with its sword-like dorsal fin, will attack the passing whale, and disturb the seals.† The beautiful dorado pursues the flying-fish, which escapes by emerging into the air with its pinion-like fins :‡ but the object here is food, or the pleasure of the chase; not animosity. The scorpius cottus evinces an angry emotion: but rather perhaps as a self-protecting repulsion, than as a purposed aggression.§ So the percus scorpœna displays an irritability, which may be referred to the same motive.‖ The fish which devour others for their subsistence act but like all the carnivorous animals of nature; and they are in

* The xiphias platypterus. His upper jaw is lengthened into a flat, sharp, ivory-like beak, which resembles a sword, but far more strong and solid. With this it attacks whales, and sometimes ships. When the "Leopard" from Guinea was cleaned in 1795, the beak of a sword-fish was found in its bottom, which had passed through the sheathing and a three inch plank, and four inches beyond that into the solid timber. It had followed the ship, and struck it as under sail, and must have broken off in the animal's struggle to disengage it.—Phil. Trans. vol. xli. ....There is now in the British Museum part of the bull of an East Indiaman with the sword of the fish driven completely through it almost to its base. The captain informed Sir J. Banks that the animal killed itself by its prodigious exertion in the blow.....Captain Crow saw some swordfish pursuing and stabbing a whale near the Hebrides, while fish, which he calls threshers, springing into the air, descended upon the whale to flap him with great violence with their tails. It was a combined attack, from which he was bleeding profusely.—Capt. Hugh Crow's Mem. 1830.

† This animal, which frequents both the arctic and Atlantic seas, 24 feet long and 12 broad, has a bony fin, often six feet long, resembling a scimitar or bent sword. It is a great enemy to the whales. Flocks of them attack the largest, fasten around him like so many bull-dogs, till he roars with pain, and often kill and devour him. It also carries on a constant war with the seals, which it pushes from the rocks into the sea by its long back weapon.—Kerr's Linnæus, p. 364.

‡ Goldsm. 540. It may sometimes happen that the tropic bird, or the albatross, is in the air when it rises; but they are not "*for ever* on the wing to seize it."

§ The father lasher. It inhabits deep places near the shores of Greenland and Newfoundland, and is very fierce and swift, though less than a foot long. Its head is armed with numerous large spines. "It follows sharks and other large predacious fish, lashing them with its spines, which it can distend in a formidable manner, until they are forced to abandon its haunts."—T. Linn, 753.

‖ "It inhabits in shoals the Mediterranean; hides itself among the sea-weed; preys on fish and crabs, and, when touched, erects and wounds with the spines of its dorsal fin." It is above a foot in length. —T. L. 755....The trachinus, in most European seas, a foot long, buries itself in the sand, leaving only its nose out; but yet if trodden upon, it strikes out the spines of its first dorsal fin with force, and inflicts a wound which causes an immediate inflammation.—*Ib.* 734.

every case the smallest number of their order. The general peace of the deep is proverbial, and its usual aspect is that of its animated inhabitants gliding cheerfully, undistinguished and undisturbing. They are for the most part indifferent or inoffensive to each other, and many are highly social and profusely gregarious. We may therefore infer, that evil passions are very rare among them; and that malignity, revenge, or fury should not be made features of their general character. Even the dreaded shark is, in its largest species, rather an unmolesting giant, except towards its appointed food.* And when the carnivorous seek their prey, we must recollect that as all fishes can swim at every point of the watery depth, the unfathomed profundity of the ocean presents abundant facility of escape, to any which happen to be endangered by their pursuers.† The natural instinct allotted to it teaches each class where it can move and live in the greatest safety; and no greater consumption can take place among the finny race, from some subsisting on others, than that proportion which the laws of their creation have appointed. This is so wisely regulated in all the classes of animals which form food to each other, that the general comfort and multiplicity seem never to be destroyed, nor even perceptibly diminished. No law of nature appears to be more nicely adapted, nor more conservatively governed, for the promotion of the common welfare, than this endangering and yet sustaining agency.

* This is the maximus squalus, or basking shark, dwelling in the arctic and European seas. "It grows to a prodigious size, and feeds on the smaller cetaceous animals, which it swallows whole. It migrates, and appears at certain times in great shoals. It is fond of lying near the surface of the water, for the sake of warming itself by the sun. But it is not very fierce."—T. Linn. 920.....In this milder temper, it is a great contrast to its ferocious relations, the zygæna or hammer-shaped shark, the blue shark, and the white one. The appendiculatus, or Botany Bay shark, is very fierce; but he is only 19 inches long.—Phillips's Botany Bay.

† As an instance of this power of escape, it may be mentioned that a person in Cornwall once saw a seal in pursuit of a mullet. The fish turned to and fro in deep water, as a hare chased by a greyhound, till, in order more speedily to escape, it glided into shoal water. The seal pursued; but the mullet, to get more surely out of danger, threw itself on its side, and by that means darted through shallower water than, with the full depth of its paunch and fins, it could have swam in, and so escaped.—Bingl. An. Biogr. vol. i. p. 150

It is in the morse and seal tribes, which display several of the qualities, and some of the bodily peculiarities, of the quadruped, that the spirit of personal battle most appears. Yet even in these this combating fierceness arises from specific causes, and is exerted for specific ends, and not as a general temper; for their usual habits are self-indulgence and indolent repose. The males of each kind fight vehemently for the particular stations they have selected, and for their connubial companions.* When attacked, they also make a sturdy and desperate resistance.† Yet these are mild when unmolested, and are found tameable and docile.‡ The largest of them has the civilized peculiarity of being monogamous, and of living together with his single wife and offspring in distinct little families, all close and peaceful neighbours to each other, like an associated tribe or class.§ Some of the species are as

* The ursine seal frequents the seacoast of Kamschatka, New-Zealand, Statenland, New-Georgia, and other places. One male lives in family with many females and their young. Each animal has a particular stone when on land, which serves for its bed, and which it never deserts. For their stations, and on account of their wives, the males fight bitterly; and their battles are always single combats.—Kerr's Linnæus, p. 121. The other species of seals have the same habit. The common seal, phoca vitulina, sleeps generally on shore, on a stone that is a considerable height above water, and in summer on rocks and sand-banks.—*Ib.* 124.

† The seal, when overtaken, defends himself vigorously with his feet and teeth, and can bear many wounds, but is killed by a blow on its nose.—*Ib.* 124.

The morse, trichichus rosmarus, or sea-horse, sometimes 18 feet long, and 12 feet round in his thickest part, defends himself with great resolution. If wounded in the water, he will attempt to sink the boats by rising under them, or by sticking his great tusks into its sides. They often sleep on the icebergs, and, when disturbed, throw themselves into the sea with great impetuosity. It was this kind which Alfred called horse-whales, in his account of Other's Voyage.—Kerr Linn. 118.

‡ The common seal "sports without fear round ships and boats, is of a gentle nature, very docile, and may be tamed and taught to obey a keeper like a dog."—Kerr Lin. 124. The one exhibited in London in 1750 answered his keeper's call, would take food from the man's hand, crawl out of water, and, when ordered, stretch himself out at full length on the ground; and when directed, would return to the water.

§ Of the trichichus manatus, the lamantin species, which dwells in the African and American seas, varying from 8 to 17 feet long, and 7 feet round, never goes on shore, but keeps near the mouths of large rivers, browsing on the grass there. It is said to be often tamed, and to delight in music. It lives in families of one male, one female, a half-grown, and a very small young one. By pasturing much on the aqua-

playful as a kitten.* In reviewing the natural character of fishes, we must, as on all other subjects, take our principles from the most prevailing phenomena; and never substitute the exception for the general law.

As fishes have not a larynx, or organ of voice, nor lungs to collect and emit the air which is to be made vocal by it, they do not communicate their meaning, wants, or feelings by sounds, like the birds and quadrupeds. Yet a few make attempts of this sort. As the thunnys sail in their vast shoals, they utter a very loud hissing noise.† The ground ling, tænia, makes a similar sound when he is handled.‡ The sciena stridens gives a small shriek when first taken out of water.§ And the grunnicus cottus also makes a squeaking noise when handled.‖ The great morse roars like a bull if disturbed, and snores while asleep.¶ The common seal moans piteously when pursued on land, as it is hurrying to the sea.** The ursine kind low like an ox;†† and the leonine one both grunts and snorts.‡‡ But all these latter partake largely of the quadruped nature. These attempts at utterance may be regarded as efforts of the animal to express its feelings at the moment, and therefore as indications that its mental nature is experiencing those feelings. It is undergoing the emotions of pain or fear, and it is remarkable, that although not organized to be vocal, the excitation of the alarm urges it to endeavour to express its

tic plants, insects settle and feed on its skin; but the sea-fowls relieve them, by perching on their backs, and picking out what is molesting them. Their sight is weak, but their hearing extremely acute.—Kerr. p. 120.

* The sea ape, trich. man. siren, five feet long, with a head resembling a dog, with sharp erect ears, and a sort of beard on both lips, is of this character. M. Steller describes it, as he saw it off the coast of America, to have been full of frolic and monkey tricks. It swam round the ship, looking at it with great amazement, sometimes raising its body a third part out of the water, and keeping erect for a considerable time; then darting under the ship, and appearing on the other side. At times it dived, and brought up a sea plant like a gourd, which it tossed up and caught it, and played many fantastic tricks.

† T. Linn. 825. ‡ *Ib.* 837. § *Ib.* 807.

‖ *Ib.* 753. ¶ Kerr's Linn. 118. ** *Ib.* 124.

†† *Ib.* 123. "After a victory, they make a noise somewhat like the chirping of a cricket; and after a defeat, or a wound, will mew like a cat."—Bingl. An. Biog. i. p. 165.

‡‡ *Ib.* 122. "Their voice is not much unlike the deep bellowing of the bull. The young ones bleat like sheep."—1 Bingl. 169.

sensations by sound. This seems to imply some unknown connexion between the feeling of pain in the living principle and those nerves and muscles of the body which can be made to signify it by sound to others. Where the organ of voice has been elaborately provided, as in the babe, we might expect an interior communication to have been prepared between the mind and its moveable larynx: but when no specific function has been made for the modification of sound into an expression of the feelings, it is extraordinary that the excited creature should seek by that to denote its apprehensions. It is another intimation that this marine class of animals have those emotions which we term mental feeling, that when the ursine seal is in that state which we call grief or vexation, it has been observed to shed a flood of tears.* This bodily effort has such an appearance of intellectual sensibility, that the rules of just reasoning incline us to hesitate before we deny its identity in this animal. Other feelings in this tribe seem to be of this character.† Fish indicate emotions which imply that a real sensation of alarm is affecting their living and thinking principle precisely at the moment of actual danger, when fear would be rational in the most intelligent being.‡

But if fish are sensitive to pain and fear, they are as susceptive of pleasurable feelings. They have the appearance of a placid and contented state of existence. No bird or quadruped seems happier. None have fewer wants. None require less means in order to be comfortable: they need only food; and yet they can subsist even without this when the abstinence is necessary. They suffer nothing from inclemency of weather, or variations of the seasons: nothing from heat, cold, frost, rain, or bitter winds. They seem to be generally exempted from disease. They are

*Kerr's Linn. 122.

† It has been stated by those who have observed this animal in its native element, "that seals delight in thunder-storms; and that during these times they will sit on the rocks, and contemplate with apparent pleasure and gratification the convulsion of the elements."—Bingley, vol. i. p. 160.

‡ Thus the gobrus schloperi, when pursued by other fish, seeks refuge in the mud.—Turt. Linn. 748....When the levigatus tetrodon is alarmed it erects its prickles.—*Ib.* 891.....When the gelatinosus of Kamschatka, a foot and a half long, is first caught, it trembles like a piece of jelly.—*Ib.* 906....When the tagara raia of the Red Sea is taken, it beats violently with its fins in great agitation.—*Ib.* 930.

always in one even temperature; they enjoy a longer continuity of health and strength than most other animals; and from these causes appear to possess a natural longevity, which in some of their classes surpasses that of man.* It seems to have been ascertained that even a carp may live for one or two centuries.† Some have the comforts of family association;‡ others, that of large mutual society.§ One kind has the gratification of suckling and nursing.‖

* Lord Bacon has thus estimated these advantages; "Most of the disorders incident to mankind arise from the changes of the atmosphere: but fishes reside in an element little subject to change. Theirs is a uniform existence. Their movements are without effort, and their life without labour. How long a fish continues to live, is not ascertained; perhaps the life of man would not be long enough to measure that of the smallest."

† Two ways of determining the age of fishes have been devised. One, by numbering the concentric circles on the scales; the other, by those in a transverse section of the backbone. On examining a fish's scale by a microscope, it is found to consist of circles, one of which is added every year. The same annual addition occurs to the backbone. By this mode, Buffon found a carp to have lived 100 years. Gesner had one as old; and Alberti affirms, that another was of double that period. Buffon's Nat. Hist. Goldsmith's Nat. Hist. vol. iii, p. 428.....The age of the skate and ray, which have no scales, must be judged of by the backbone. Dr. Forster saw carp in Prussia between 60 and 70 years old.—Phil. Trans....In the royal pond at Marli, some particular fish were alive in the middle of the eighteenth century, which were traditionally recorded to have been placed there in the reign of Francis I. in the sixteenth. A pike was found to be 90 years old; and Gesner states, that in 1497 one was taken in Swabia that had a brazen ring with the date of 1230. But it is desirable to have such facts confirmed by modern experience.....Buffon thought that whales have lived 1000 years; but Schultz argues, not unreasonably, that this inference is not sufficiently grounded.—Sch. Arist. Anim.

‡ The seals, and walrus or morse, live in the society of their own families and of each other, and are frequently seen basking together by scores and hundreds. The porpoises are seen swimming together in large herds, sometimes in regular lines very slowly, and tumbling about in the waters; at other moments, darting forwards with great velocity in an irregular manner.—Kerr's Linn. p. 363....."When a manati is hooked or struck, the whole herd will attempt its rescue."—Bingl. vol. i. p. 154.

§ The numerous fishes that live and sail together in vast shoals are instances of this kind of association.

‖ The common whale suckles her young, and takes care of it with great affection.—Kerr's Linn. 357. The female seals also suckle their offspring for six or seven weeks, in caverns or hollow rocks, and then take them out to sea when able to take care of themselves.—Kerr, p. 194. The morse tribes also suckle their young with attention and fondness. The dugon trichichus has breasts like a woman.—Kerr, p. 118.

Their sportiveness evidences their enjoyment;* and their motion by swimming, being always governable as to its celerity by their own will, is gentle or rapid, just as they please; and must therefore be an exercise as pleasurable to them, as those of our own race who can imitate it find and declare it to be to human sensibility. Even their fear can subside when the reason for it ceases.†

The just conclusion from an extended and impartial review of the habits and appearance of this class of animals seems to be, that fish have a general tranquillity of character and nature, combined with much agility of movement; and possess, for the most part, that peaceful comfort of life and feeling which gives the great charm to sentient existence in every form and region. Animated and pacific; many species fond of social combinations; the more insulated most commonly inoffensive to each other; those appointed to be the food of others, becoming so without contest or passion; each with few bodily wants or exciting gratifications—the great deep usually presents to our consideration an immense space of animal harmony and of temperate enjoyment. No life can be simpler than theirs—none seems more universally soothing and pleasurable. Pain has

* The seals are seen wallowing in their miry beds, and tumbling playfully over each other.—Kerr, 122.....The dolphin and porpoise are often seen sporting on the water. Many fish display the same kind of joyous activity on the water....Crantz mentions, that walruses, when playing about the water, have been frequently observed to draw, with their long tusks, sea-fowl beneath the surface, and after a little while to throw them up into the air. "As they do not eat these birds, this can be done only out of wantonness and frolic."—Bingl. i. p. 154...."A seal tamed in an island near Edinburgh had all the affection and playfulness of a dog. It fawned about its masters, licked their hands, and met them on their return. It would snatch up a stick or brush, scamper off to the water, and swim about with it to a distance. It always came back with what it had taken, and laid it at their feet, fawning and fondling all the while."—The British Naturalist.

† When the seals are attacked, "They fall into the utmost confusion, and tumble down, and tremble so violently, that they are scarce able to use their limbs. When, however, they find it impossible to escape without fighting, they become desperate, and turn on their assailant with vast noise and fury. But when they find themselves uninjured, and that there is no intention to assail them, they soon overcome their fear of mankind. Steller, when he was on Behring's Island, lived for six days in a hovel that was surrounded by these animals. They were soon reconciled to him; would observe with great apparent calmness what he was doing; would lie down near him; and even suffer him to take hold of and play with their cubs."—Bingl. An. Biog. vol. i. p. 168

but little or brief residence among them; for, even when absorbed by larger ones for nutriment, they are swallowed without laceration, and entombed in darkness and death before they are well conscious of their change of situation. Death therefore is to them what the Druids, in their mythological theories, sang it to be to man:

> A change which can but for a moment last—
> A point between the future and the past.

Thus they represent to the contemplative mind an actual image of placid happiness in life, and of unfelt departure from it.

Such are fish.—It is our advantage above them, that we can add to their physical placidity the enjoyment of the moral principles; the mental sensibilities; occasional delights of exquisite joys; intellectual activities; the sublimer feelings of our highest destination; and the gratifying pleasures of social communication. All these occupy and attract us, and furnish many a banquet in the succession of our revolving years. Yet, amid life's varied streams and sources of transport and pain, often mingled and often alternating, we learn at last to prefer those milder and more certain or enduring pleasures which calmly sooth us, to the bustle, the labour, and the excitements that engage and animate our youth and maturer strength. Agitation and emotion at length lose their charm: they disturb more than they amuse us. As age advances to its sober evening, we perceive and appreciate the value of conscious life without pain; of sedate tranquillity; of reposing, yet not inactive, thought; of sensibility without perturbation; of patient hope; of resting moveability; of sensations that please, but do not agitate; of intellectual rumination; and of those solemn aspirations of sacred foresight, of prospective gratitude, and of humble reliance on the great mediatorial Benefactor, which close our mortal days with true dignity, and make even dissolution an inestimable blessing.*

* Among the living creatures in the waters are the TESTACEOUS and CRUSTACEOUS classes. The first are remarkable for the softness of their bodies, the continuity of their parts, the simplicity of their mouth, and the permanency of their attachment to their calcareous dwellings. Their shells are principally composed of carbonate of lime, with a small portion of animal matter. They are divided into three arrangements: the

LETTER X.

On the Nature and Phenomena of the mental Principle which appears in the Fish Order of animated Beings.

THE habits of fishes are too little known for us to form sufficient ideas of the extent and degree of the mental faculty which accompanies their living principle. The similarity of their brain to that of birds was remarked by one of our distinguished anatomists of that grand function of our present mode of existence.* Their organs of sense resemble ours in the principle of their construction, with particular modifications to suit them to the watery medium in which they live.†

That they possess and exercise volition many show.

BIVALVES, including oysters, cockles, muscles, scallops, &c.; the UNIVALVES, as periwinkles, limpets, welks, and snails; and the MULTIVALVES. Bosc has classified these under several subdivisions, in his Hist. Nat. des Coquilles, in the Dict. Naturelle. In his system, the arrangement is more methodical, and the genera more definite, than in the Linnæan system. The Supplement of the Ed. Encycl. art. Conchology, details the classification of Bosc. Conchology comprises the shells which protect the molluscous animals.—*Ib.*

The CRUSTACEOUS have a fibrous texture, articulated members, complicated organs of mastication, and at stated periods renew their coverings. Their shells contain phosphate of lime.—Suppl. Ed. Ency. p. 284.

* Dr. Th. Willis. As he had traced many resemblances between the brain of man and that of quadrupeds, so he remarks of birds and fishes, "Both these species of animals, coetaneous, and as it were twins at their creation, have their affinity in nothing more strongly than in the fabrication of the brain." He proceeds to detail the similarities.—Cereb. Anat. 67–76. The parts wanting in the one are absent in the other. The additional peculiarities are exhibited by both.

† Borelli examined the optic nerves of the swordfish, thunny, and others; and disputed with Eustachius and others on their structure: contending that they were cross-barred and complicated like cloth, and not longitudinal fibres.—Lett. in Malph. Op. vol. ii. p. 1–7.... The optic nerves interenssate in them, as in animals. The medulla oblongata is exactly analogous to that of birds; fitting the one to swim in the sea, and the other for that flight in the air which may be called an aerial natation.—Willis, 75. Their cerebellum resembles that of the more perfect animals.—76. Casserius Placentinus ascribed olfactory nerves to them.—*Ib.*

The two swordfishes who plunged their beaks into the ships they pursued, apparently supposing them to be whales, or some analogous substance, exhibited a vigorous determination of their will to their own perdition.* Yet, though mistaken in the object, the blow was not ill judged, nor the force with which it was given; for this would have buried their snout so far in a whale as to have enabled them to have extracted the nutritive matter they sought by the action, before the whale could have loosened its wounded body from their attack. To mistake the keel of a vessel for the animal, was not a greater error than a seaman's mistaking a whale for an island, or a fog-bank for a real shore, which has been repeatedly done.†

The fish which climbs trees displays an equal exertion of peculiar will, though its exact intention is not known, beyond the general idea that it is seeking for food, or something agreeable to its perception.‡ The salmon exhibits a remarkable instance of determined effort to effect a rational purpose, in the extraordinary leaps which it makes to surmount cataracts or other obstacles which impede its progress as it ascends a river. This requires, not only will, but correct perception and judgment, as its muscular exertion must be regulated by the extent and nature of the hinderance which it meets with,§ and by a perception of the height to which its spring must reach. Other fish can make such

* See before, note [*] p. 216. The whale endeavours to strike its assailant with its tail; of which one blow would destroy him. The swordfish, by great agility, avoids the descending ruin, and, bounding in the air, again falls upon the whale.

† Milton has noticed one of these illusions—

> "Him haply slumb'ring on the Norway foam
> The pilot of some small night-foundered skiff
> Deeming some island, oft, as seamen tell,
> With fixed anchor in his scaly rind
> Moors by his side."—Par. Lost. B. 1.

‡ The perca scandens, which inhabits rivulets in Tranquebar; about a palm long. By the means of the spines of its gill-covers, and the spinous rays of its other fins, it crawls up trees.—Linn. Trans. vol. iii. p. 62. .... Lieut. Dalderff saw it ascending a palm growing near a pool of water, and had got up five feet when observed. It was very tenacious of life, for it moved about on dry land many hours after it was taken.—*Ib.* .... Dr. Shaw calls it the climbing sparus.—G. Zool. vol. iv. p. 475.

§ Mr. Pennant watched them at Port Aberglasslyn, where they had to pass a perpendicular fall. They sprang up quite straight, and with a tremulous motion. They do not always succeed in their first leap, and in that case repeat it, if they can, till they have cleared the difficulty

elevating starts when they choose.* The several species of flying-fish display, in like manner, voluntary exertions on emergencies of danger, in order to escape it, and the idea how they can do so: a spontaneous motion for a reasonable purpose, at the proper moment, and continued as long as the necessity lasts, or the ability to perform it remains.†

The periodical migrations of so many tribes, for the purpose of fecundating and depositing their eggs, display a mental instinct in rational, persevering, and efficacious operation. The same combination of action and judgment appears in the fish that crawls on land in search of water;‡ and in the night journeys of eels, for obtaining food.§ But

The leap is sometimes 7 or 8 feet.—Brit. Zool. vol. ix. p. 284.....“ On the river Liffey, in Ireland, there is a cataract about 19 feet high, up which these fish leap. They frequently fall back many times before they surmount it.”—Bing. An. Biog. vol. iii, p. 270.

† The trout leaps several feet out of the water.—T. Linn. 847. And the trichiurus of South America often leaps into boats as they pass by. —*Ib.* 712.

* The scorpœna volitans, in the fresh waters of Amboyna and Japan, less than the river perch, thus raises and suspends itself for a time, when pursued.—T. Linn. 757.....So the trigla volitans of the Mediterranean and Asiatic seas flies out of the water in every direction when endangered.—*Ib.* 834.....The exocœtus volitans is the most celebrated for this exertion. It is done in all by the pectoral fins; but the flight can be supported only while they are wet. Captain Tobin watched them about Otaheite. They use their tail to supply their pectoral wings with the needed moisture. He frequently saw the dolphins and bonitos in pursuit of them; but none could go beyond 100 yards without dipping in water for a fresh supply of wet. Its length is from 12 to 15 inches. —Penn. Br. Zool. vol. iii. p. 333. Wood, Zool. vol. ii. p. 187.....They are sometimes in danger from sea-birds while in the air; but this coincidence of their presence cannot very often occur. The casual incident has been dolorously magnified into an habitual circumstance, and the fish supposed therefore to lead a miserable life. It is most probable that, having the power of the aerial excursion, it often uses it for its own amusement.

‡ The callichthis siluris “inhabits small running streams of Europe, and when these are dried up, crawls across meadows in search of water.” When confined, “it is said to perforate the sides of reservoirs for the purpose of making its escape.”—T. Linn. p. 839.

§ During the night they wander along the meadows in search of snails and worms.....Dr. Plot mentions this fact in his History of Staffordshire. That they can travel out of water is certain....M. Arderon saw them sliding up the dry flood-gates of the waterworks at Norwich, six feet above the surface of the water, with the greatest facility, to get into the water above the gates.—Phil. Tr. vol. xliv. p. 395....Dr. Anderson, as he walked by the Dee, observed a close connected stream of young eels, two inches long, moving along the edge of the river in shoal water. They

when they move with the semblance of following a conductor, in a marshalled form, we cannot avoid inferring in them the same degree of reasoned intention and judgment which we ascribe to animals who exhibit such habits.*

A distinct action of judging mind appears in the fish that directs the projectile blow on the insects it perceives, and desires to make its food; for this requires a careful proportioning of the force to the distance, and to the amount of the water that is thrown; in this operation an accurate perception and instantaneous judgment are necessary in order to produce so continually a successful result.†

The fishes that hide themselves in the mud, to be in safety from their assailants, or to avoid danger, or to procure com-

moved on, night and day, without interruption, for several weeks. Their progress was about a mile an hour. That place was six miles from the sea. The shoal was not less than from 12 to 20 feet in breadth, and very long. "Whence they came, or whither they went, I know not. I am told the same phenomenon takes place every year at the same season."—And. Bee. Wood, Zool. vol. ii. p. 135.....Eels are in some places so numerous, that in the Garonne 60,000 are said to have been taken in one day by a single net..... Dr. Bloet mentions that many wagon loads of them are conveyed from the mouths of the Baltic into Saxony.—*Ib.* p. 137.....The following passage explains what Dr. Anderson saw: "Eels produce their young about the end of summer. They are said to descend into the sea for this purpose, and to take the opportunity of the most obscure nights, and when the rivers are flooded by accidental rains, to seek the ocean. The young fry begin to return into the fresh water about the end of January; and continue their passage for the three following months, during which time they are taken in the river Arno by millions; but of so small a size that a vast number of them goes to a pound."—Gold. Nat. Hist. vol. iii. p. 257.

* The lavaretus salmo "inhabits Northern Europe; and in spawning time approaches the mouths of rivers in immense shoals, swimming near the surface, in an acute-angled column, with a leader at their head."—T. Linn. p. 852. Phil. Trans. vol. lxiii. p. 149.... The thunny migrates in a regular parallelogram.

† The chætodon rostratus, about six or eight inches long, frequents the seashores in the East Indies. When it observes a fly sitting on the plants that grow in shallow water, it swims to the distance of five or six feet, and then, with surprising dexterity, ejects out of its tubular mouth a single drop of water, which *never fails* striking the fly into the sea, where it soon becomes its prey. Hommel, a Dutch governor, had some of these fish put into a tub of water, and afterward pinned a fly on a stick within their reach. He daily saw these fish shoot at the fly, and with such dexterity that they never failed to hit their mark.—Phil. Trans. vol. liv. p. 89.....Pallas describes the sæna jaculatrix as securing flies by a similar contrivance.—*Ib.* vol. lvi. p. 186. ...The sparus insidiator, in the Indian seas, ten inches long, catches aquatic insects, like the chætodon, by its snout, which it can lengthen out into a tube.—T. Linn. p. 785.

fort, evince what resembles a perception and use of the fittest means to effectuate their wishes.* The salmon, when storms come on, sinks to the bottom; as if with a right judgment to avoid what would injure it:† while those to whom the agitation will be rather pleasurable than pernicious, become sensible of the impending change, and rise to the surface of its lake or stream as it approaches.‡

The gymnotus and others benumb, by an electrical discharge, the intermeddler that disturbs it, or the fish that it desires to arrest and swallow for its nutrition.§

All these are actions for reasonable purposes, very similar to what all right judgment would do under such circumstances. The whale displays not merely maternal regard, but even affection, for its mate, and has shown the deepest sorrow when deprived of him.‖ That they are attracted by

* "The schloperi gobius, in the lakes of Amboyna, when pursued thus, hides itself.—T. L. p. 748.....The flat-fish tribe, pleuronectes, bury themselves in the sand, except their heads, to escape the notice or attack of those who seek them for prey.—*Ib.* p. 761.....The tobianus, or sand lance, on the recess of the tides, being exposed by the retreat of the water, penetrates a foot deep in the sand.—*Ib.* p. 714.....The fossilis cobitis, a resident of the muddy streams, withdraws into the mud in winter, as if to avoid the severity of the cold.—p. 837

† T. Linn. p. 846.

‡ As the glanis silurus, which inhabits the deep fresh waters of Europe and the East.—T. L. p. 840....So the fossilis cobitis, which is very restless before a storm, disturbing the water, gets as near as possible to the surface.—p. 387.

§ Bloch, Ichth. v. p. 38. Shaw, Gen. Zool. iv. p. 41. The gymnotus abounds in the rivers of Surinam. The shock takes place if only one hand hold the fish and the other is put into the water over its body. Its effects exactly resemble those of atmospherical electricity, communicated by the same conductors, and intercepted by non-conductors.—Dr. Garden. Phil. Trans.....The silurus electricus, in the African rivers, communicates a similar shock when touched, but less violently.—T. L. p. 840.....So the tetrodon electricus, described by Paterson in the Phil. Trans. It inhabits the holes of the coral rocks in St. John's Island. The raja torpedo, described in the same work by Walsh, has also this electrifying power.

‖ The incident mentioned by Anderson is, that as two whales were sailing together, a male and a female, one was harpooned by the whalefishers. It made a long and formidable resistance. Its companion attended and assisted it, and when the wounded one expired, stretched itself with great bellowing sounds upon the dead fish, and voluntarily shared its fate.—Golds. Nat. Hist. vol. iii. p. 443.....A female grampus and her young one were ashore when attacked. The mother got off, but finding her young one detained, came back again to release it or to share its fate. Waller's poem of the Summer Islands notices this circumstance.

light, and even distant light,*—that any should be affectible by colours† and by external appearances, which is asserted even of the whale,‡—imply a sensitivity which has a close relation with intellectual impressions, and with some feelings or associations in themselves, that we have not yet discriminated. Some also appear to distinguish musical sounds, and to be interested by them,§ and even to perceive the meaning of other signs that affect their sensations.‖

The dolphins exhibit both social and parental attachments,¶ or at least habits which claim the name of feelings,

* The spinachia gasterosteus, a sea-fish, follows a light.—T. L. p. 829. ....A shining light so attracts fish, that the Indians on the Canadian rivers fix a large piece of blazing bark on their canoe in their night fishing, and choose that time of darkness as the best for their object.—Head's Forest Scenes.....In every sea it has been found that fishes follow light. "On lighting a fire in the boats, they become surrounded by fish. The eastern islanders therefore make such a flame. It is the constant usage of the American boatmen; so of modern Greece and Sicily, and all over the Mediterranean. Lighthouses are points of attraction for fish, as effectual as for woodcocks."—Jour. Science, No. 42, p. 265–267.

† The salmon "is said to be fearful of any thing red, but allured by a white colour."—T. L. p. 846.

‡ The Greenlanders have a traditional belief that the better they are dressed the less the whale avoids them, and therefore go out in search of them in their best apparel, which they put off as soon as they have struck and mastered their victim.—Wood's Zoog. ii. p. 126.....If this impression were really founded on experience, we might infer that the whales had distinguished the harpooners from the festive dress, and, not aware of the fraudulent hypocrisy, supposed its wearers to be, like other navigators, traversing the ocean without any design of hostility to themselves. If the fact be true, it implies much attention, observation, and discrimination, not erring in its aim, but made erroneous by deceit.

§ The large manatus or lamentin is said to delight in music.—Kerr's Linn. p. 122.....Gesner affirms that sturgeons are delighted with sounds of various kinds; and that he has seen them shoal together at the notes of a trumpet.—Gold. N. H. vol. iii. p. 498.....Nuremburgius mentions pond-fish that assembled at the sound of a bell, to receive their food.—Nat. Hist. L. 3.....Dr. G. Sergius saw a similar circumstance in the gardens of the Archbishop of Saltzburg, where the trouts came together to the gardener when he rang a little bell.

‖ A friend has often seen a gentleman, who had particularly attended to a few fish in his pond, wave his hand gently over the water, when he wished them to come to him to be fed; and that slight alteration, for the moment, of the light on the water, was sufficient to bring them to him, and take the worms he offered from his fingers.

¶ Fishermen say that dolphins, like whales, love to live in society, and have much attachment to their little ones, and defend them courageously when pursued.—Bull. Univ. 1827, p. 108.

from their similarity to the effects of such sensibilities. Their brain has much approximation to our own.*

Nothing is a more striking indication of the possession of a mental faculty in an animal than its susceptibility to that process and result which we call taming. It implies attention to the teacher, a comprehension of his meaning, a perception of the connexion between the means he uses and the effect he purposes, a desire to comply with his wishes in order to obtain the gratification which follows the docility, and a self-governing power to coerce its natural habits for the time, and to assume the others which its instructer or feeder imposes. Eels exhibit this teachability ;† carps have become familiar,‡ and so has a trout ;§ even pikes have acquired such habits.‖ Seals likewise become tractable like

* The dolphin's brain, like that of the orang outang, is distinguished by its large size. After the orang's, it is that which approaches nearest to that of man's, though, if compared with its proportion of nerves, spinal marrow, and cerebellum, is much less in magnitude than the human. In the one dissected, the hemispheres were smaller in proportion, for they did not entirely cover the cerebellum. It had more width than length, compared with man's, though other mammalia have it otherwise. Its cerebral hemispheres showed more numerous circumvolutions and furrows than all other animals. These were more numerous in proportion than even in man. Its cerebellum was proportionably greater than in man, and the base of its brain was larger.—Bull. Univ. 1827, p. 106–108.

† In Otaheite "eels are great favourites, and are tamed and fed until they attain an enormous size. These pets are kept in large holes two or three feet deep, partially filled with water. On the sides of these pits they generally remained, excepting *when called* by the person who fed them. I have been several times with the young chief when he has sat down by the side of the hole; and by giving a shrill sort of whistle, has brought out an enormous eel, which has moved about the surface of the water, and eaten with confidence out of its master's hand."—Ellis, Polyn. Res. vol. ii. p. 286.

‡ Dr. Smith describes the old carp at Chantilly as so tame, that when any one approached their pond, they came to the shore in such numbers and eagerness as to push each other out of the water, and as if asking for the bread that was given them.—Tour to Contin.....So the carp in the King of Prussia's garden came to the shore in order to be fed.—Wood's Zoog. vol. ii. p. 208.....The golden carp, or goldfish, are kept in ponds in China, where they are regularly fed, and taught to rise to the surface at the sound of a bell, in order to receive their nourishment.—Shaw, Gen. Zool. Penn. Brit. Zool. vol. iii. p. 374.

§ A farmer near Pontypool had a trout 27 years in his well. His family became fond of it, and it would frequently eat worms out of the children's hands, but if a stranger came, it would hide in a small hole for the rest of the day.—Heref. Journ. 3 Sept. 1828.

‖ A pike, in a pond at Ely, became so tame as to follow the waving of a handkerchief to any part of the pond.

dogs.* What these could be trained to, others are most probably as capable of imitating. There is nothing in their configuration that should make this degree of improvement their exclusive particularity. Some of the inhabitants of the water exhibit an extraordinary degree of memory, a faculty that is always connected with other powers of mind.†

The conduct of the pilot shark, the little fish that acts to him as a jackal was reputed to do towards the lion, implies faculties of observation, thought, will, decision, and communication, quite congruous with the same capacity in any reasoning being.‡ The personal vigilance of the seal, and the stationing of a watching guard, are actions of foresight, reasoning, and a selecting judgment.§

There must be some social feeling or gratification in being

*Kerr's Linn. 124.

†That salmon should remember the spot where they have once spawned, and return to it again after a long voyage to the sea, and be able to know their way to it from the vast ocean, is one of the most extraordinary exertions of fish intellect that can be mentioned. Yet M. De la Lande, who had fastened small rings of copper to the tails of some of them to ascertain the fact, was assured by the fishermen that they had returned to the same place for three succeeding seasons.—Wood's Zoog. vol. ii. p. 176.....A farmer of Aberdeen brought home a young seal, and fed it for three days with bread and milk. His wife disliking its presence, it was taken out of the town by the man and some friends, and thrown into the sea; but it returned to them, notwithstanding every endeavour to repel it. The tallest then walked into the sea as far as he safely could, and threw it into the waves, while they hid themselves behind a rock; but the animal again advanced to land, and found them out in their hiding-place, and remained with them, till the farmer took it back once more to his house.—Bingl. p. 100.

‡M. Geoffroy, in 1798, near Malta, observed a shark advancing to the ship, preceded by two fishes, who went twice along it from one end to the other, as if to see if it was any thing that would suit him, and then resumed their former route. The shark never lost sight of them, but regularly followed their course, as if he had been drawn by them. The sailors threw into the sea some lard on a hook: the fish, who had passed to some distance, stopped, and the two smaller ones went to examine it, and returned to the shark, who then swam after them to the substance. He did not see it until they marked it to him, when, rushing forward to seize it, the hook pierced his lip, and he was hoisted on board.—Geoffroy, in Bullet. des Sciences, No. 61. Wood, Zoog. p. 228.

§Mr. Pennant mentions, that though seals frequently leave the water to sleep in the sun on the rocks, they are extremely watchful, and every minute or two raise their heads, to see that no danger is approaching them. It has been remarked of the species called phoca leonina, which sleep in herds in miry places, that each herd places at a distance some of the males as sentinels, and these never fail to give alarm if any thing hostile approach.—Kerr's Linnæus, x. p. 122.

together, which induces so many of the fish tribes to habits of association. Such voluntary society indicates that they derive pleasure from the aggregation.* The periodical migrations of the herrings, in their immense shoals, so distinctly dividing themselves at particular stations into separate masses, and each taking a different course, and coming regularly to the same stations at the same recurring seasons, display determined purpose, spontaneous agency, and suited knowledge of positions, course, and places, which imitate human will and judgment.† Other fish shoal with similar aggregations of concurring or sympathetic will and decision; and in numbers which make calculation look like exaggeration.‡ The regular recurrences of such emigrations indicate directing instincts; which, if they originate within the animal, imply ideas, choice, purpose, object, and perseverance. But on this mysterious subject our real knowledge only enables us to say, that in their stationary and

* The common dolphins generally swim in troops. They are often seen together, from five to twenty, gamboling about the ocean. One body followed Sir R. Hawkins 1000 leagues.—Bingl. i. p. 170. . . . . The porpoises are seldom seen but in groups varying from six to thirty. The spermaceti whales generally swim in troops of males and females. So the sea unicorns. The seals and walrus assemble in numerous herds.

† Pennant describes their shoals as distinguished into several columns five or six miles long and three or four miles broad; a space which, as they sail very close together, must comprise some millions. They appear annually in June off the Shetland Isles, in their largest body. One vast portion goes to the west of Ireland, where they divide again; one fleet of them moving into the Atlantic, while another passes into the Irish Sea.—Penn. Brit. Zool. vol. iii. p. 336. . . . . Mr. Donovan describes them as coming from the North Ocean in one immense column, and as separating as soon as they reach the Orkneys and Shetland into three divisions. Of these, one passes along the east of Scotland; another to the Hebrides and Ireland; while the most considerable body moves between Cape Wrath and Lewis Isle, and enters the bays off the west coast of Scotland.—Don. in Farm. Mag. May, 1825. . . . . They are in such multitudes, that the seabeach has for many miles been covered with a bank of stranded herrings several feet in depth.—British Naturalist.

‡ The pilchard shoals give us a specimen of their numbers. Dr. Borlase assured Mr. Pennant, that on 5 Oct. 1767, there were at one time enclosed in St. Ives Bay 245 millions of these fish.—Pen. Brit. Zool. vol. iii. p. 345. . . . . The others of these immense emigrants are the cod; the haddock, the whiting, the mackerel, the tunny, and the herring. Some travel a distance from 3000 to 4000 miles in a season. The shoal of haddocks that was seen on 10 December, 1766, was three miles broad and above forty long, off the Yorkshire coast. A similar one appeared the next year on the same day; so exact were the next visitants to their period. All the shoals of others come every year, always in the same month, and frequently in the same week.

natural abode they seem tranquil, abstinent, and happy;* and that the emigration from thence to the distant coasts peopled by man, to which they periodically move so multitudinously, is so connected with human subsistence and benefit, that it seems a reasonable inference that special impulses or instincts of movement are given to them, on purpose that mankind may benefit from their immense productivity.†

The contrivance of the frogfish to attract its prey within its reach had drawn the notice of the ancients; and it is now named piscatorius, from the circumstance.‡ Intention, judgment, adaptation of the action to the purpose, and patient vigilance appear in their habit.

The susceptibility to fear is strikingly shown in the lobster. They are apt to cast their claws, on a loud clap of thunder, or on the firing of a cannon;§ but under the excitation of alarm, they do what has all the appearance of an intellectual action. If at a distance from their usual hold in the rock when frightened, they will spring up towards it, though many feet off, and regulate, in the instantaneous

* "Of all migrating fish, the herring and the pilchard take the most adventurous voyages. Herrings are found in the greatest abundance in the highest northern latitudes. In those inaccessible seas, which are covered with ice for a great part of the year, the herring and pilchard find a quiet and sure retreat. In that remote situation, they live at ease, and multiply beyond expression."—Golds. 530. Their food is insects, but as these only appear at their season, the chief part of the herring's life must pass without them.

† "From this most desirable retreat Mr. Anderson supposes they would never depart; but that their number renders it necessary for them to migrate. As with bees from a hive, they are compelled to seek for other retreats. For this reason, the great colony is seen to set out from the icy sea about the middle of winter."—Golds. 530. The doctor adds this strong but too rhetorical intimation of their amazing numbers: "If all the men in the world were to be loaded with herrings, they would not carry the thousandth part away."—p. 591. Tropes and figures of speech are sometimes used to signify what it is beyond our power to number; but the allusive hyperbole has its proper limits.

‡ This fish, which grows to seven feet long, is very sluggish, and swims with difficulty, but it has two long slender filaments upon its head, immediately above the nose, which are thicker, and round at the end. It lurks behind sand-hills or heaps of stones, and throwing these appendages over its head, which resemble worms, the little fish are induced to approach them as they float, either for play or food, till they come within his reach, when he springs and seizes them.—Turt. Linn. 226.....Pliny mentions this fish, which the Greeks called batrachos, and the Latins rana.

§ Pennant, Brit. Zool.

motion, both their impulse and direction so exactly, as to throw themselves into their place of safety through an entrance hardly sufficient for them to pass through.*

The annual migrations of the land-crabs of Jamaica, from the mountains to the sea, there to deposite their young brood, exhibit also judging and determined volition in steady and persevering activity for an important and rational end.†

The parental and filial sensibility and attachment of the cetaceous fishes, the walrus and the seal tribes, are so like the same affections in many quadrupeds and in the human race, that it would be an apparent inconsistency to give them any other denomination.‡ Wherever joyous feelings

* "As is frequently seen, by the people who endeavour to take them, at Foley Bridge. They spring, tail foremost, as fast as a bird can fly. The fishermen can see them pass about thirty feet, and suppose they may go much farther. Athenæus remarks this circumstance, and says that the incurvated lobsters will spring with the activity of dolphins."—Wood's Zoog. vol. ii. p. 546.

† "The animals not only live in a kind of orderly society in their retreats in the mountains, but regularly once a year march down to the seaside, in a body of some millions at a time. The sea is their place of destination, and to that they direct their march with right-lined precision. No geometrician could send them to their destined station by a shorter course: they turn neither to the right nor to the left. They will attempt to scale walls, to keep the unbroken tenor of their way. They are commonly divided into three battalions, of which the first consists of the boldest and strongest males. These are pioneers, who march forward, to clear the route, and to face the greatest dangers. The main body is composed of females, which never leave the mountains till the rain is set in for some time; they then descend in columns of fifty paces broad and three miles deep. Three or four days after this, the rear-guard follows, consisting of males and females neither so robust nor so numerous as the former. The night is their chief time of proceeding; but if it rains by day, they do not fail to profit by the occasion. When the sun is hot, they make a universal halt, and wait till the cool of the evening. They are sometimes three months in getting to the shore."—Goldsmith, from Labat's Voyage, vol. ii. p. 221.

‡ "The fidelity of the male and female whale to each other exceeds that of most animals. When a fisherman had killed one of a pair, the other, who had assisted in its defence, stretched itself on the dead one, and shared its fate."—Bingl. vol. ii. p. 160.....The maternal whale carries her young one with her wherever she goes: when hardest pursued, supports it between her fins,—though wounded, still clasps it, takes it with her to the bottom, and rises with it to give it breath.—*Ib.* 161.....When a female grampus and her cub were attacked, the mother escaped, but finding her young one detained, she rushed back to share its fate.—*Ib.* 175.....So Captain Cook states "that the female walrus will defend her offspring to the very last, and at the expense of her own life; nor will the young one quit its dam, though she be dead: so that if one be killed, the other is a certain prey." They display also a great attachment to each other.

exist, and attest their existence by spontaneous movements of visible hilarity, we may safely infer a correspondent proportion of mental sensibility. Even the cumbersome whales display such emotions.*

All the actions we have thus alluded to seem to display a thinking mind in varied operation, in addition to that living principle which every animal shares in common with the vegetable kingdom.†

Such was the fish creation—a race of beings both feeling and thinking, in that particular structure of body and residentiary element to which they were assigned. Like the vegetable tribes, they have been made to be useful to man, both in contributing to his sustenance and in supplying him with many important conveniences. But independently of the human race, they have been created to be happy beings in themselves. From their vast numbers and varieties, and the comparatively small knowledge which man has of them, and the few out of their numerous species which have been converted to his use, we may assume that they were made principally on their own account, and for the display to us of our Creator's mind, power, thoughts, inventions, and imagination. They enlarge our knowledge of his omnipotence, and give us ocular sensations of its multifarious potentiality.

Fish seem to be more exclusively confined to themselves than any other classes of animal life. For, excepting the few species of birds and amphibious quadrupeds which seek them as food, no animal but man knows or notices them. They live in an element which is mortal to all but themselves; and no other creature, nor even man, can mo-

* A naval officer describes his amusement near New-Brunswick, "in looking at the *gambols* of the whales, who here congregated in greater numbers, and seemed more frolicksome and playful. I saw these immense creatures *jumping* entirely out of the water, though generally their unwieldy weight allowed little more than half their length to rise above the surface, on which they fell upon their broadside with a noise like thunder."—Un. Serv. Journ. Nov. 1831.

† The vital principle in fish can survive the action of frost. Those which were caught by Captain Franklin's party in Winter Lake froze as they were taken out of the nets, and became in a short time a solid mass of ice. But if in this completely frozen state they were thawed before the fire, they recovered their animation. This was particularly the case with a carp, which recovered so far as to leap about with some vigour after it had been frozen for thirty-six hours.

lest them, but as they choose to float near the surface of their waves, or to be tempted by the baited hook that descends deeper. But they are equally unfitted and unable to have any concernment with other beings. They die in no long time if removed from their habitual fluid: and thus they are entirely beings of the world of waters, and have no functions or faculties for any other region or mode of existence. In general, they are made to be helpless to all assailants. Animals have teeth and claws, or horns, and other weapons for fight or escape, but few fish have such endangering instruments. They are an instance that an innumerable class of animated beings may exist in great comfort and activity, whose prevailing character is that of inoffensive and unresisting helplessness. They are subjected to death, and several of their species receive the termination of their being at times, by serving as the food to others; but most of those whose life is not thus intercepted enjoy it for a duration which few other animals experience.

But they are principally interesting to the contemplative student for the curious modification which they exhibit of the principles of life and of mind. They show the phenomena of these as they occur in the finny forms, functions, and element. We see in them fish mind and fish feelings, and find similarities between these and the faculties of the higher orders of animals and of ourselves, which deserve all the attention they may excite, and enlarge our conceptions of the nature of the intellectual qualities. They contribute to prove, that life and mind do not arise from form, nor depend upon it; for they exhibit these as equally existing in every configuration, and in despite of diversity. No changes of figure prevent or suppress them, nor does the matter of the bodily substance united with them either cause or destroy them. Life and mind are therefore independent of all material structure, and are some great principles added to it and co-existing within it.

LETTER XI.

A brief Review of the Mollusca, Testacea, Zoophyte, and Infusoria Orders; and of their Indications of Feeling and Mind.

It has already been intimated that one of the great characteristics of creation has been that of multitudinous diversity. This peculiarly appears in the smaller classes of animated nature, and among them, in those other orders of beings which, besides the fish and crustaceous animals, inhabit the sea and other waters. These have received the discriminating denominations of mollusca, testacea, zoophyta, and infusoria. Most of them are of a miniature size, and the latter of that diminutiveness to which we give the general name of animalcules. The greatest part of them inhabit the ocean; but the last kind abound in land waters, and are found in most infusions. They all belong to the division of the invertebrated animals. They have no vertebræ.

The MOLLUSCA are described as "naked simple animals, not included in a shell, but furnished with limbs." The slug, limax, is placed by Linnæus as the first genus of the class. There are many genera, and of some of these the species are very numerous. The absence of vertebræ has occasioned them to be considered by some as an inferior class of beings. This degradation in the scale of existence is not satisfactory to other naturalists, who see in their smaller frames indications of a careful and complicated construction.*

The actinia, or sea anemone, is a numerous genus of this

* M. G. Cuvier thinks that the mollusques in general, and especially the cephalopodes, have a *richer* organization; one in which there are more viscera analogous to those of the superior classes, than the other animals without vertebræ. Hence the mollusca should not be confounded with the polypi and other zoophytes, but be placed a degree higher in the scale. But though their organization approaches that of the vertebrated, yet it is not composed in the same manner, nor arranged on the same plan.—Bull. Univ. 1830, p. 447.... M. Geoffry St. Hilaire takes the other side of the question against M. Cuvier.—*Ib.* p. 449.

order.* It is viviparous; it has no aperture but the mouth. Feeding on shellfish and other marine animals, which it draws in with its tentacula, it rejects in a short time the shells and indigestible parts. It is usually fixed to some basis, and assumes various forms. When its tentacula are all extended it has the appearance of a full-blown flower.† Some of its species adhere to rocks,‡ others to sea-weeds and millepores,§ others to stone.‖ One kind, bellis, the sea daisy, has a head like the calyx of a flower.¶ Some appear to like an association with their fellows.** Their sizes vary, from several inches to the smallness of a pea.††

The scylla is a genus, one of whose species lives on the ocean, among the floating sea-weed.‡‡ The sepia, or cuttle-fish, has a short head, with large eyes, and a mouth like a parrot's beak. It has eight arms, with numerous suckers.§§ One species was eaten by the ancients, and is liked by the present Italians.‖‖ Another, of a large size, is also a pleasant food.¶¶ In hot climates some grow to a prodigious

* Dr. Turton enumerates 36 species of it. The body is oblong, cylindrical, fleshy, and contractile. Its mouth is expansile, surrounded with moving cirri.—Linn. Syst. vol. iv. p. 100.

† The plumera is a beautiful species.—*Ib.*

‡ The rufa adheres to rocks. The viridis inhabits near Alexandria, fixed to submarine rocks. It is an inch in diameter, and has several rows of tentacula. The gemmacea is on the coast of Cornwall, in the fissures of the rocks.—*Ib.* 102 and 104.

§ The undata has this position. The priapus adheres to shells in the Red Sea.—*Ib.*

‖ The coccinia is fixed to fuci and stones. The alba, scarce an inch long, is found fixed to stones in the Red Sea.—*Ib.*

¶ *Ib.* 103. The dianthus, or sea carnation, inhabits the rocky coasts of England, adhering to the under part of rocks. It hangs down like a yellow fig.—P. 107.

** The sociata, near Barbadoes, is fixed to rocks by its smaller end, and is generally found in large groups.—*Ib.* 104.

†† The nodosa, which inhabits the depths of the Greenland Sea, is four inches long. So is the gigantea, in the Red Sea. But the pusilla, met with in the ocean, lat. 57°, is only the size of a large pea. It forms the principal food of whales.—*Ib.* p. 102, 103.

‡‡ *Ib.*

§§ *Ib.* 118. "The body is fleshy, receiving the breast in a sheath, with a tubular aperture at its base. In most species are two pedunculated testacea."—*Ib.*

‖‖ The officinalis species, living in the ocean. Whales and plaice also take it. The arms are frequently eaten off by the conger eel, but are then reproduced.—*Ib.* 119.

¶¶ The tunicata. Its large body sometimes weighs 150lbs.—*Ib.* 120.

magnitude, and are then formidable for their gigantic holders and absorbing power.*

The medusa is another singular genus of this mollusca order, with a multitude of species.† They consist of a tender gelatinous mass of varying figure, furnished with arms, or a tentacular process. The larger species, when touched, cause a slight tingling and redness, and therefore usually called sea nettles. They are supposed to form the chief food of the cetaceous fish. Most of them shine with great splendour in the water.‡ This property of disengaging and emitting light is one of those mysteries of the luminous fluid which has not been adequately studied. This most universal agency of nature is as yet very imperfectly known, though always about us, within us, and acting constantly around us with silent but irresistible power. The aurita species of the medusa is frequently found floating in the sea, from two to three inches in diameter, and when the sun shines upon it a beautiful splendour is reflected from it.§ The noctiluca kind wander in large groups in the Mediterranean and Atlantic, illuminating the waves, and if shaken in sea-water they discharge sparks of light.‖ The size of this genus varies, from twelve inches in diameter to an eighth part only of that extent.¶

The ASTERIAS, or starfish, or sea star, is another abundant genus of the molluscous animals.** They are all inhabitants of the sea, and have the faculty of renewing the part of their body which they may lose by violence. Some of their colours are interesting.†† But the most curious of

* This is the octopus of the Mediterranean and India seas. In the latter it sometimes grows to a large size, the arms becoming nine fathoms long. In these seas the Indians never venture out without a hatchet to chop off their arms, in case it should attempt to fasten on them, and to draw them into the water.—T. Linn. 119.....This species, "when opened, is said to exhibit so strong and splendid a light as perfectly to illuminate a dark room."—*Ib.*

† Dr. Turton distinguishes 43 species. The body gelatinous, orbicular, and generally flat underneath. The mouth central beneath.—P. 121.

‡ *Ib.* 121. § *Ib.* 123. ‖ *Ib.*

¶ The octostyla species is a foot in diameter. The corona is 4 inches across. While the mullicina is but 1½ inch in diameter.—*Ib.* 127, 128.

** They fix to the bottom, by swimming on the back and bending the rays. There are 45 species mentioned of this genus, in the Linnæus: many are in the north seas.—P. 133.

†† The rosia is of a rich rose colour in his body, above, and sometimes inclining to claret.—*Ib.* 133.

their species is the caput medusæ, which appears in most seas, from the beautiful network of its construction.*

Peculiarly numerous now, and as peculiarly important for its fossil abundance in our ancient rocks, and therefore for its diffusion in the primitive ages of our globe, is the echinus, or sea urchin. All of its class are residents in the sea, and in most seas many are eatable. Their body is roundish, covered with a bony, sutured crust, and generally provided with moveable spines.† Their pores are each furnished with a retractile tentaculum or feeler, by which the animal affixes itself to any object and stops its motion. Many have ten avenues of pores, several only five.‡ It is not a large animal.§ Many of its species that are found in the fossil state have not yet been met with in the present ocean.‖

The testacea order are distinguished from the mollusca by having the shelly abodes, which the others are without. They are soft animals, of a simple structure, and covered with a calcareous habitation or shell, whose pleasing variations of colour and figure make conchology an agreeable study. It will be always an amusement, gratifying, innocent, and instructive, to collect the shells we meet in our walks on the seabeach and elsewhere; to find out by comparing them with their descriptive catalogues, to what genus, and to what species of that genus, they belong, and to arrange them accordingly. This habit will introduce us to one portion of the great temple of created nature.

The testaceous genera are very numerous, and their spe-

* "Its five rays divide into two smaller ones, and each of these into two others. This mode of subdividing is continued to a vast extent, gradually decreasing in size, till at length the ramifications amount to many thousands, forming a beautiful network. Its colour is sometimes pale or reddish white; sometimes brown."—T. Linn. 135.

† No fewer than 128 species are specifically noticed by Dr. Turton. They are mostly five-valved; the mouth placed beneath, and generally armed with five sharp teeth. The spines are connected to the outer skin by very strong ligaments, and are the instruments of motion.—p. 136.

‡ *Ib.* p. 136–140. The mamillatus of the South Seas has ten winding avenues.—p. 140.

§ The pustulogus is hardly an inch high, and about two in diameter. Another is three-fourths of an inch in height and one and a half in diameter.—p. 143.

‖ Of this order, those which the animals found in many of the testacea resemble, are, the limax, the aseidia, the tethys.

cies still more so.* The lepas, or acornshell genus, is in most seas, and adhering to rocks, stones, or shells.† Some of its species attach themselves to the bottoms of ships and pieces of wreck.‡ The animals in the phloas genus perforate clay, spongy stones, and wood, while in the younger state. As they increase in size they enlarge their habitation, but remain imprisoned within it.§ Some of them contain a phosphoric liquor of great brilliancy in the dark, and which illuminates whatever it touches or happens to fall upon.‖

The mya kind penetrate the sand and clay at the bottom of the sea, burying themselves and their shells wholly or in part.¶ One species of this produces pearl in large quantity and mother-of-pearl.** The river Conway, in Wales, had formerly much celebrity for producing pearls of great size

* Dr. Turton specifies 37 genera of these. Some have a great multiplicity of species: the chiton 28; the lepas 32; mya 26; solen 23; tellina 94; cardium or cockle, 52; mactra 28; venus 154; arca 43; anomia 51; mytilus, or the muscle, 64; nautilus 31; bulla 43; conus 81; cypræa 120; nerites 75; strombus 53; trochus 118; turbo 151; serpula 47; voluta 144; murex 181; patella 220; and helix, the snail genus, 200 species.—T. Linn. 161–610.

† The balanus species so fix themselves in the greatest abundance in the European and Mediterranean sea. The balanoides also, though less numerically. The intertexta is found on the British coasts, attached to oysters; and the costata on the Pembroke shore, to rocks. The verruca species fixes on the ostrea islandica, and others.—T. Linn. 165–170.

‡ The tintinnabulum frequently occurs in this situation, in the European, American, and Indian seas. The anatifera species, or the duck-barnacle, is in most seas, and generally fixed in clusters to the bottoms of vessels, and to old pieces of floating timber.—T. Linn. p. 166, 169.

§ T. Linn. p. 172. "Thus immersed, it lives in darkness, indolence, and plenty, it seems perfectly content with being enclosed in its own sepulchre. The influx of the sea-water satisfies all its wants. It is found in immense numbers at Ancona. It is also along the shores of France, and on some of the coasts of Scotland; and is deemed a great delicacy."—Bingley, iv. 310.

‖ The dactylus species inhabits among the rocks of Europe, and shines by night. It is five inches long.—*Ib*....The pusilla, in the American and Indian seas, penetrates the bottoms of ships. The teredula, on the Belgic shores, lodges itself in timber; while the hians on the American islands perforates calcareous rocks and corals.—*Ib.* 173, 174.....The animal of this genus is an ascidia; its shell bivalve divaricate; hinges recurved, united by a cartilage.

¶ Its animal is an ascidia; its shell bivalve, generally gaping at one end.—T. L. 174.

** The shell is 5 inches broad, and 2½ long; and is often corroded by worms.—*Ib.* 176.

and value; but as pearls are deemed a disease in the fish, like calculi in the human body, their abundance in the Welsh river would indicate that its water had some quality or substance which gave the mya a sickly tendency.*

The ostræa, or oyster genus, is well known to us. The maxima species, which has the shell that the pilgrims to the Holy Land used to wear on their return, is in most eastern seas in large beds.† The edulis kind, which is our repast, occurs in the European seas, affixed to rocks, or in large beds.‡ The parasitica attaches itself to the roots and stumps of the trees which grow close to or overhang the water.§

The anomia genus, with its strap-shaped body and bristles of fringe, is a bivalve, whose species are now in several seas, adhering to other things,‖ and is one of those primitive creations that is often found fossil.¶ The mytilus, or muscle genus, has one species which produces the true mother-of-pearl, and frequently the most valuable pearls.** It has another, the lithophagus, which is distinguished by its stone-eating power and appetite.†† Another kind pre-

* T. L. The glycemeris species is 10 inches broad, by 5 long.—*Ib.* 179.

† It is 5 inches long, by 5½ broad.—*Ib.* 256. The malleus, a rare species in the Indian and South seas, is 6 inches long and 4½ broad.—p. 273.

‡ The old shells have often an anomia fixed to them, and are frequently covered with serpulæ, lepades, sertularia, and other marine productions.—*Ib.* p. 273.

§ T. Linn. 277. It is more especially seen on the mengifera, and is often as large as the palm of the hand.

‖ The ephippium species is often sticking to the common oyster, though 2 inches long, and 2¾ broad. The squamula is in the seas of Europe, adhering to crabs, oysters, and other fish, as the truncate does to corals there. The pubescens, of the size of a cucumber seed, occurs on zoophytes. The flexuosa is in the Norway seas, on the madreporas prolifera.—T. Linn. 281–287.

¶ The cramolaris, pectinata, gryptius, pecten, dorsata, and some other species, are found both living and fossil: but the plicatella and lacunosa are known only in the fossil state.—*Ib.*

** It is the margaritiferus species which inhabit the American and Indian seas, eight inches long, and a little broader. The inside is beautifully polished. The outside is a sea-green, or else a chestnut or a bloom colour with white rays.—T. L. 290.... Linnæus and others found that by perforating the shell the animal could be forced to produce its pearls. So, if part of the inner surface be scraped off, and a small grain of mother-pearl be introduced, the animal will effuse its pearly fluid upon it, and in time make it a fine pearl.

†† It lives in the European, American, and Indian seas; of a cinnamon colour; three inches long and one broad. It penetrates and eats away coral rocks, and even the hardest marbles.—*Ib.*

fers to live in limestone, each in its distinct chamber.* The species which we eat is found in large beds, generally adhering to other bodies by its long silky beard.† Others adhere to coral, seaweeds, zoophytes, and rocks.‡ Some kinds are in rivers and ponds.§ One species attains greater bulk in the land-waters than at sea;‖ and some are sought after by particular birds as a favourite food.¶

The pinna is a genus which deserves our notice, because its inhabitant may be called a marine silkworm. It produces a large quantity of fine strong byssus, which the Italians weave into a sort of silk.** It surpasses also most of the other testacea in the size of some of its species.††

* The rugosus, in the seas and lakes of north Europe. It is usually found lodged in limestone, in great numbers. Every one has a separate apartment, with apertures; but these are too small for the shell to pass through without breaking the stone.—T. L.... The phlœdis of the north seas penetrates beds of coral and its rocks. The corallophagus, of the American and Indian Ocean, also perforates them.—*Ib.* 295, 296.

† The edulis. Its ordinary length is two or three inches; but it becomes much larger within the tropics, and smaller as it lives near to the north. It is in both the Indian and European seas. It is a rich food, but injurious to some, or at some times.—T. Linn. 291.

‡ The cristagalli species is affixed to gorgonia, in the Red Sea and Indian Ocean; the hyotis and frons on beds of coral; the cordatus, in the South Sea, adheres to corals and marine substances; the modiolus is found in the European, American, and Indian seas, adhering to fuci and zoophytes. This kind is 6 inches long, and nearly 3 broad. The discors is found in the south seas of Europe, affixed to rocks and other shells by its beard.—*Ib.* 289–296.

§ The cygneus is frequent in rivers and ponds; from 2 to 5 inches broad, and nearly 3 in length. The zellensis, found in stagnant waters in Germany, of the unusual size of 7 inches broad by 3 long. The stagnalis, in Lake Schwasca, is still larger, being 8 inches broad, and 4½ in length.—*Ib.* 293–298.

‖ The polymorphus, in the Russian sea, is of the size of a plumstone, but in fresh water it becomes four times as large. It adheres in masses to stones and marine substances, by small tufts.—T. Linn.

¶ The faba of the Greenland sea species, which is affixed to rocks by a bronzed beard, is the food of the anas hyemalis and histrionica. The anatinus, in its fresh water abode, is 5 inches long and above 2 broad. Ducks and crows are extremely fond of this, and of the cygneus kind. When the crows find their shell too hard, they fly up with it to a great height, and then drop it on a rock to break it, when they pick out the meat.—T. Linn. 294.

** T. Linn. 300. The animal of the pinna or nacre is a limax. The shell is bivalve, fragile, and gaping at one end, with a beard or byssus; the hinge without teeth. It is generally found standing erect in the smoother waters of bays, with the larger end a little open. Many are found a very rich food.—*Ib.*

†† The nobilis, in the Adriatic and Mediterranean, and in the American

The argonauta class is immortalized by the admiration of antiquity, and by its belief that it taught mankind the use of sails; which Pope has so pleasingly alluded to in his most valuable poem, the noblest specimen of didactic poetry which mankind in any language yet possess.* The argo species is that which has procured this celebrity. The name nautilus is given by Linnæus to another genus with numerous species; of which one kind is admired for its large and interesting shell, which in the East is made into a rich drinking cup.† It is found adhering to the rock of seaweed and to coral rocks.‡ Several of its species are also found in the fossil state, evincing that it has been an inhabitant of the former world as well as of the present.§

The conus genus is very pleasing in the colours of its shell; and is remarkable for one of them being so rare and prized as to have been valued at one hundred guineas.‖ The cypræa, or cowry, becomes in one of its species the circulating money of the African negroes. It is fished up by

seas, is 7½ inches long by 3½ broad. The squamosa of the Mediterranean is 13 inches long and 6½ broad. The rudis of the Atlantic and America is from 12 to 16 inches in length, and from 4½ to 8 in breadth; while the rotundata of the Mediterranean is sometimes 2 feet long.—T. Linn. p. 301, 302.

* The arts of building from the bee receive;
Learn of the mole to plough; the worm to weave;
Learn of the little NAUTILUS to sail,
Spread the thin oar, and catch the driving gale.
Essay on Man, Ep. 3.

Its animal is a sepia or clio, and inhabits the Mediterranean and Indian seas. The shell is univalve, spiral, involute, and membranaceous, with one cell only. It has five species.—T. L. p. 304. See following page 251.

† The pompilius of the Indian and African ocean is this species. It is very large and finely variegated with brown flexuous streaks under the outer covering, which is white. The inside has a most beautiful pearly gloss.—*Ib.* p. 305. The shell of this genus is distinguished from that of the argonauta by being, though a univalve, divided into several departments, communicating with each other by an aperture.—*Ib.*

‡ As the balthicus, in the Baltic; and the siphunculus, in the Sicilian sea.

§ The lituus of the Red Sea has been found fossil; so the orthocera of the ocean abounds in many ancient rocks. Its species helicites was among the fossils of Maestricht; and the belemnita, or thunder-stone, is often found in this state.—*Ib.* 307–310. It has thirty-one species.

‖ *Ib.* 315. This is the cedo mulli of the South and American seas. Its shell is yellow, painted with red, in eleven belts, and milk-white within. The conus has 81 species. Its animal is a limax. It is univalve, convolute, turbinate, and smooth.—*Ib.*

their women; the bed of the sea being the natural mint for this their simple coin, suiting only the simpler state of their rude society.*

The bulla genus, of very varying size, is noticeable for one of its many species having with its little body an organ like the gizzard of a fowl for the mastication of its food.† Amid the multiplicity of the voluta, one of its kinds, in China, is used for beads and necklaces there; and another is fixed by the natives of Tanna in a handle, to serve them as a hatchet.‡

Of the many other genera of testacea, the murex, in some of its numerous species, contains the purple die of the ancients; and in its larger shell furnishes an instrument of musical sound.§

The helix, or snail, has been used both for medicine and food, though it is now denounced as a destructive visiter of our gardens.‖ The teredo genus is the shipworm, which is found so often on the sides and bottoms of navigating vessels. It is nearly as active in its injurious operations there, as the termites ant is to timber on land.¶

A very peculiar and distinct order of animals, and in many of its genera only in very modern times admitted to be such, appears to us in the zoophyta; a term expressing animal plants or vegetating animals, and defined to mean composite animals efflorescing like vegetables. This order

* T. Linn. 343. It is a univalve. Its animal a slug. There are 190 species mentioned of this genus.—328-351.

† *Ib.* 351. The shell is univalve and convolute; its animal a limax. Though in one kind the ovum is four inches long, the birostris is no bigger than a bean, the hydatis but a small pea, and the spelta like a grain of wheat.—*Ib.* 348.

‡ These species are the monilis and the episcopalis. The latter shell is seven inches broad. The animal is a limax. Under this genus Dr. Turton details 144 species.—364-377.

§ The loco species, which inhabits the Chinese shores, whose shell is four or five inches long, contains a purple juice in a vesicle on the neck. —T. Linn. 349. It is the tritonis, which inhabits India, the South seas, and the Mediterranean, whose shell, sixteen inches long, is used by the natives of New-Zealand as their musical instrument, and by the Africans and many nations of the East as a military horn.—*Ib.* 448.

‖ The pomatia snail was introduced into England by Sir Kenelm Digby, for medical purposes. The snail was a favourite dish with the Romans, and is still used for food during Lent in many parts of Catholic Europe. It is oviparous, and tenacious of life. The eggs of the hortensis, or garden snail, resemble small peas.—*Ib.* 513 530.

¶ *Ib.* 600. The animal is a terebella.

embraces the sponge, coral, and polype classes, with a few others.*

The sponge is allowed now to be a living being; but it long remained a question whether it was a vegetable or an animal one. Its animality is now the belief of the best naturalists. It is described as fixed and torpid; of various forms, composed of network fibres, or of masses of small spines interwoven together, and clothed with a gelatinous flesh full of small mouths on its surface, by which it absorbs and rejects water.† The officinalis species, or common sponge, is found in the Archipelago, the Mediterranean, and the Indian Ocean, adhering to rocks by a broad base. It often is seen with small stones, shells, and particles of sand enclosed within its cells, and is sometimes pierced and gnawed by marine animals into irregular winding cavities; but it gives no indication of a sensitivity greater than that of plants.‡ The oculata species in the British seas is from five to ten inches high. One kind, on the rocks of Guinea, has a stem as thick as a finger, and branches as quills, surrounded with small, obtuse, shaggy tufts.§ Some are in the land-waters;‖ and one in the ocean is full of gelatinous flesh.¶

The coral classes, to which in our preceding letters we have alluded, are distinguished in the Linnæan arrangements into several genera. The tubipores consist of erect, hollow, cylindrical, parallel, and aggregate tubes, varying into ten

* T. Linn, 614.

† *Ib.* 656. This genus has 49 species, noticed by Dr. Turton.

‡ "The internal part, when cut perpendicularly, consists of small tubes, composed of reticulated fibres, and ending, on the outside, in an infinite number of small circular holes, which are the bibulous mouths of the animal; each of these is surrounded by a few erect, pointed fibres."—P. 658.p

§ *Ib.* 659.

‖ The lacustris, at the bottom of the lakes in England and Sweden, is creeping, and brittle, with erect, round, obtuse branches. It is covered with scattered pores, in which are sometimes found, during autumn, small, bluish, shining globules..... The fluviatilis is a dull green, erect and fragile. It has scarcely the appearance of animal life, but it has a fishy smell, and pores full of green gelatinous granulations. The friabilis of the German lakes is cinereous, friable, and the food of fish there.—*Ib.* 662.

¶ This is the tormentosa species on the British, African, and Indian coasts, adhering to marine substances. When fresh, it is of a bright orange colour; when dry, it is whitish, and very light; and, if broken, resembles the crumb of bread.—*Ib.* 659.

species;* madrepores are a coral, with lamellate, star-shaped cavities: they have been divided into 117 species.† The millepores are of a similar nature, mostly branched, and covered with cylindrical turbinate pores.‡ The cellepore is an analogous genus, with its coral somewhat membranaceous, and composed of round cells.§ The isis coral has a stony jointed stem, covered by a soft porous cellular flesh or bark; the mouths beset with oviparous polypes.‖ The antipathes and gorgonia genera are distinguishable from the foregoing, which are all stony corals, by their horny or bony nature.¶ The alcyonium, is still more fleshy and leathery.** There are several other curious genera placed

* The animal of these is a hydra or polype. The alcicornus species is often found in the Indian and American seas, incrusting pieces of rocks, gorgona, and cocoanuts. The cærulea occurs in vast masses in the Indian Ocean. Several kinds are in the north seas. The miniacea is a beautiful little coral, the smallest of its genus, being seldom above one-fourth of an inch high.—*Ib.* 633–636.

† The animal is a hydra or polype, and lives in the North and Greenland seas, and also in the Mediterranean and Indian Ocean. It has 8 species.—*Ib.* 640.

‡ Six species are particularised.—*Ib.* 641.

§ The musica species, a bright scarlet, is fixed to rocks and other corals in the American and Indian seas. It consists of tubes rising over each other by stages, like the cells of a honeycomb, divided by partitions. The serpens is frequently cast on the shores of the Baltic, European, and American seas, adhering to stalks of fuci and corallines. The stellata and struæ are only seen fossil. The fascicularis now on the Greenland shores is sometimes met with in calcareous rocks.—T. Linn. 614, 615.

‖ This animal resembles a medusa. The verruncaria species, an orbicular star, with a convex disk full of tubulate pores, and radiate border, inhabits the European, Mediterranean, and Red seas, adhering to marine vegetables, and the softer zoophytes. It is the size of a split pea, and seems an intermediate species between this genus and the tubipore and millepore. The fungites kind in the Indian and Red seas, from one to six inches diameter, has sometimes a footstalk. The porpita of a lupin size, in the Indian and Red seas, and the ananas of the Mediterranean and America, are frequently found fossil.—*Ib.* 616, 617.

¶ The antipathes has a stem expanded at the base: internally it is horny, and beset with small spines; externally it is covered with a gelatinous flesh, beset with numerous polype-bearing tubercles.—T. L. 643. ....The spiralis kind inhabits the Indian, Mediterranean, and North seas. It is "of a horny, hard, black substance, exceedingly brittle; very long, and variously twisted, and about the size of a writing-pen."—*Ib.* ....The gorgonia genus has a stem which is corky, woody, horny, bony, or coriaceous, composed of glassy fibres; or like stone, striate and tapering, becoming spongy and friable when dry. Mouths with polypes cover the surface of the stem. 41 species are noticed.—*Ib.* 645–651.

** The stem is "fixed, fleshy, gelatinous, spongy, or coriaceous, beset with polype-bearing stellated cells." 28 species are enumerated.—*Ib.* 652–656.

in this order of zoophytes, which will gratify the patient naturalist:* of these, the sertulariæ has the power of emitting a fiery light.†

One of the most remarkable class of animated beings which the Creator has chosen to make part of his earthly creation, is that diminutive order which is named the infusoria; described to be minute, simple animalcules, seldom visible to the naked eye. The order embraces fourteen genera: of these, the first has a contractile body, covered with a shell.‡ Cognate with these is the vorticella genus, nearly as diminutive, with a naked contractile body, seated on a stem, and furnished with collate, rotatory organs.§ The trichoda is a worm, also invisible to the unassisted eye, pellucid, hairy, or horned, yet in numerous species.‖ The

* As the flustra; with a fixed stem, consisting of numerous cells united together and woven like a mat, in which its polypes reside.—T. L: 663.....The tubularia; with a tubular stem fixed at the base, the animal "proceeding from the end of the tube, and having its head crested with tentacula."—P. 665.....The corallina; is coralline, common, in one of its species, on every shore, growing in clustered tufts, about the thickness of a large thread, and sometimes used as a vermifuge.—P. 672. .....The sertularia; with a horny stem, producing polypes from minute shells with their eggs or living young, and in 77 species.—P. 675.....The penatula, or sea pen. This is not affixed. It is of various shapes, supported by a bony part within, naked at the base. The upper part generally has lateral ramifications, with rows of tubular denticles, that produce radiate polypes from each tube. It has 18 species, one of which is the encrinus.—687, 690.....The hydra, or common polype, which fixes itself by its base It is gelatinous and contractile, and furnished with setaceous tentacula or feelers. It inhabits fresh waters, and produces offspring or egg from its sides, which fall off. These seem at first small papillæ, but increase in length until they assume the parent form, and then drop off. It has the power of reproducing its parts when destroyed; and if cut in any direction, each separate part becomes a perfect polype.—*Ib.* 691.

† "If the leaf of a plant to which they adhere receive a smart stroke with a stick, the whole sertularia will be most beautifully illuminated, every point from which a polype issues appearing as if on fire."—Bing. 344.

‡ The branchionus, in 12 species. Of these, the mucronatus has a tail with *moveable* spines. The quadridentatus swims with great swiftness —T. L. 710–712.

§ The polypiora species, in the European seas, adheres to the fuci seaweed, and appears to the naked eye like a white point. The convallaria is in fresh waters, on other substances, with the same appearance.—*Ib.* 694–697.....Fifty-seven species are noticed.

‖ The grandinella species of this order occurs in fresh water, and in vegetable infusions, like a minute pellucid globule. The cometa kind, is seen in pure water, a pellucid globule with bright molecules. The granata in stagnant waters; an opaque globule, with a pellucid margin,

cercaria is another class, imperceptible to the ordinary sight, yet found to be a real existence, pellucid, and furnished with a tail.* Ten other genera of the same order of miniature beings, but with a full and distinct individuality of animal life, have also been traced, studied, and delineated; all unknown to our more distant ancestors, and only revealed to our knowledge by the astonishing powers of the microscope and of the luminous fluid.†

All the orders mentioned in this Letter consist of invertebrated animals, or those which have no vertebræ. They appear, to those who estimate importance by size, to be insignificant things; but magnitude is no criterion of either life or mind. The trees of the forest spring from the little corculum in their seeds. In that small spot their vital principle, organization, and qualities are abiding. Animals likewise emerge from the larger space of the maternal ova. So that the infusoria which the natural eye cannot see, or beholds only as a shining point, are not very much less than that speck in the embryo of the lion or the man, which the vital principle of both, and the soul of the latter, first occupy and animate. This is as great a mystery as it is a certainty. We see the fact; however incompetent we may be, in our present ignorance, to comprehend or explain it.

surrounded with short hairs. The sol species is found in water which has been kept some time; its body round, crystalline, dilatable, and contractile, with divergent rays of hairs longer than the diameter of its body. The linter appears in infusions of old grass. It varies in shape, and sometimes has rotatory motions. The innata of salt-water has a contractile funnel form. The lynceus appears in water which has been kept some time: its intestines are said to be eminently visible. Sixty specimens of this genus have been named.—T. Linn. 703–710.

* Of its 13 species, the gyrinus occurs in animal infusions. The inquieta in salt-water. This kind changes its shape into a spherical, long, or oval figure, but always preserves its tail. The mutabilis is found in stagnant pools in such innumerable myriads as to cover the whole surface with a shade of green or red. The catellus appears in water where flowers have been kept. The head moveable; the abdomen twice as long as that, and filled with intestines. The tenax is in water with which the teeth have been washed.—T. L. 710–712

† These are the gonium, the colpoda, the paramecium, the cyclidium, the vibrio; leucophra, bacillaria, enchelis; volvox, so named from its quick rotatory motions; and the monas, the most simple of all know animated beings. Of this genus, the termo occurs in most animal and vegetable infusions. "Of all known animals, it is the most minute, being so extremely delicate and transparent, as often to elude the most highly magnifying powers, blending, as it were, with the water in which it swims."—Dr. Turton's Linn. p. 712-794.

Mind can exist in a point, as well as in the giant form into which that vital speck gradually enlarges.

But this division of animated nature has not in most of its classes the same number of organized senses which the creatures of greater bulk possess, as M. Cuvier has remarked.* Yet all these inferior orders exhibit indications of sentient, feeling, thinking, willing, and acting mind, as well as more important animals. In the mollusca order, the luna calendula sinks of its own volition into a hole when disturbed.† The holutheria genus contract or expand as they please.‡ The larger species of the medusa, when touched, produce a slight tingling and redness in the hand of the molester; and one of its kinds, on feeling contact, contracts itself into the form of an apple.§ A new mollusca has been found to form a thread to guide it back to its shell when it moves from it.‖

* "In the invertebrates, the senses are seldom to be met with all together in the same object. The cephalopods have no smell. Several gasteropods can neither hear nor see. The animals of bivalve shells have neither eyes, nor ears, nor smell; and the zoophytes, and the races below them, have, it is affirmed, only the single sense of touch, which in them is so extremely delicate, as to be acted upon even by light.—Kirby, vol. iv. p. 235. Cuvier, Anat. Comp. vol. ii. p. 362.

† Turt. Linn. 105. Mr. Hughes says of this sea marigold: "I often attempted to pluck one from the rock to which they are affixed, but could never effect it. As soon as my fingers came within two or three inches, it would immediately contract, and shrink back into the side of the rock. If left undisturbed for two or three minutes, it would again gradually come into sight, expanding, though at first very cautiously; but would again contract with surprising quickness when my hand approached."—Hughes, Nat. Hist. Barbadoes.

‡ T. Linn. 108. When the echini are alarmed, they immediately move all their spines towards the object, and wait an attack, as an army of pikemen would present their weapons.—Bingl. 303.

§ The cucumis of the Greenland sea. p. 112. The sea anemonies, though destitute of eyes, are evidently affected by light; for if a candle be held over the glasses in which they are kept at such a distance as to communicate no heat, yet they regularly close, and do not open again till the light is removed. Two of them contested for a piece of fish, like dogs for a bone. The Abbé Dicquemare so placed it, as that two anemonies had each hold of an end. Each swallowed on till their mouths came in contact. They struggled for three hours which should retain the share it had taken, till the gray one lost its hold. The yellow then slowly absorbed the rest. The gray made one more attempt; but before he could fasten on it, the other, by a final effort, sucked in the end.—Bingl. 294.

‖ Mr. Rang, who has made a new monographie of the aplysia genus, has remarked a new genus of molluscas gasteropodes, which he calls litiopa. This little animal climbs up marine plants, and leaves its

In the testacea order, the argo of the argonautæ genus, the admired nautilus, when it means to sail in its little shell, discharges from it that quantity of water which made it heavier than the marine fluid around it, and by this act, rising to the surface, erects its arms and expands the membrane between them to catch the air, and the breeze then drives it forward like a vessel under sail; while it hangs down two others of its arms over its shell, to serve as oars or as a guiding rudder.* One species of the snail, as winter approaches, covers the aperture of its shell with a calcareous lid,† as if to keep itself from the cold. The solon not only moves its shell into the sand, and raises it by a dexterous use of its powers, at its will, but also gives a striking instance of its persisting determination to avoid a danger it has experienced.‡

Among the zoophytes, the sponge absorbs and rejects water from its small mouths §§ and its tormentosa species, stings and raises blisters on the hand that meddles with it.‖ The tubularia fabrica has not the power to protrude its body from its coral tube, but it expands its cirri beyond it when the tide covers it;¶ and its stellaris species, whenever the water is in the least degree agitated, retracts its fine

shell to do so; but keeps attached to it by spinning out a thread, on which it returns to it when it pleases.—Bull. Univ. 1831, p. 377.... The thread is the guide it provides for itself back to its home.

* T. Linn. 304. In some places, where the sea is not agitated by winds, great numbers are occasionally seen diverting themselves by thus sailing about. On the least alarm, they retract their arms, and take in as much water as will sink their vessel, and disappear downwards. In this escape they are so quick, that Le Vaillant's people, with all their care and speed could never catch one.—Bingl. 326.

† *Ib.* 513. The slug, in order to descend safely to the ground from the branch of a tree, causes a flow of viscous secretion towards its tail, where it forms it into a thread, which it lengthens to the necessity, at the rate of an inch in three minutes. Bingley, An. Biog. vol. iv. p. 289.

‡ This razor-fish, to sink into the sand, makes its tongue into a little shovel to form a hole, and then into a hook, to sink that deeper, till it has buried itself sometimes two feet. When it chooses to regain the surface it shapes its tongue into a ball, and pushes up its shell.

§§ *Ib.* 65. When a little salt is thrown into its cell, it rises up immediately from it; and will, on this excitation, come to the surface as often as it is applied; but if it be once seized by the hand, and afterward allowed to retire into its hole, the salt will be strewed in vain, for it will never make its appearance again. Bingl. 314.

‖ *Ib.* 659. ¶ *Ib.* 668.

white cirri within its tube.* The coral architects rival the bee in skill, perseverance, and exactness.

Among the infusoria, the urceolaris B. that seems but a small white speck, has a double rotatory organ, which it protrudes or conceals at its own pleasure.† So the vorticella convallaria, though only a white point to the naked eye, can suddenly contract its stem in a spiral manner, and in a moment expand itself again,—as the inclinans species occasionally contracts itself to half its length.‡ The bomba trichoda moves with velocity, and assumes various shapes.§ The vibrios, from paste and blighted wheat, are like little eels, and very prolific.‖ The petty volvox even enter into personal combat, like two angry quadrupeds.¶

Many of the other infusoria change frequently the shape of their minute bodies; all apparently the actions of spontaneous volition. As far as the movements of all these classes of petty animals can be understood, they seem to be those of a vital principle of the same kind with that which insects, fish, and the other brute animals possess. Several of these three orders of marine beings can live without additional nutriment, as many fish seem also to do.** Their

* *Ib.* 669. The madrepore animals, "when undisturbed, protrude themselves from their cases, and oscillate from left to right with an extremely quick motion. On any alarm, they immediately withdraw inwards, and nothing is to be seen but the naked stem and branches."—Bingl. 338.

† *Ib.* 693. It is frequently found on the stalks of duckweed.

‡ *Ib.* 697, 698.

§ *Ib.* 703. So the vermicularis dilates and contracts itself.—705.

‖ In the latter part of the year they are oviparous; at other seasons they produce live offspring. Their most gigantic individuals are seldom one-tenth of an inch long. If grains of blighted wheat be soaked for a few hours, they appear in great numbers even when the wheat has been kept dry for years.—Bingl. 353.

¶ Le Martiniere detached two from the rest: "Like two strong and active wrestlers, they immediately rushed together, and attacked each other on every side. Sometimes one would dive, leaving the adversary on the surface of the water: one would describe a circular movement, while the other remained at rest in the water. Their motions at length became so rapid as no longer to allow me to distinguish the one from the other."—La Martin. Ap. Bingl. 356.

** Even the slugs can exist for a great length of time, for several months successively, without food.—Bingley, An. Biog. vol. iv. p. 281.... Sea anemonies lived about twelve months without any other food than the sea-water, though they would swallow pieces of a muscle offered to them.—*Ib.* 293.... When the pholas pierces the marble and lodges in it, growing too large to get out by its hole, it is sufficiently nourished by the sea-water overflowing upon it.—*Ib.* 310.

external configurations greatly differ from those of the rest of animated nature; but it is a pleasing proof that one Creator has made the whole, and upon one grand general system of construction, although this has been surprisingly diversified in its specific details, that the more exactly these inferior orders are studied, the greater analogy is found to prevail between them and the rest of the sentient kingdoms.*

LETTER XII.

The Bird Creation—Their Plumage and Song—Power of Flight, and Migrations—Numbers and Classes—General Character—and Mental Faculties.

A NEW system of exterior figure, and a new species of beauty, in the three main sources of the beautiful in material things, and to the surveying eye—form, motion, and colour—arose to visible existence in the feathered creation. From the same causes of agreeable emotions, the fish excite pleasurable sensations in those who gaze upon their placid activity in the calm and clear ocean. And these feelings arise also within us as we handle the shells of the testacea, which are always so neat in figure, polish, hues, and completeness, and often impressively interesting in their most lovely tints and more elegant shapes; all announcing the refined taste and minute execution of their invisible designer. But the BIRDS eminently surpass all the marine classes in their appeals to our sense of beauty in their attractive appearance. Form, motion, finish, and colour are the elements of what is beauteous in both orders of being: but the

* M. G. Cuvier observes of the cephalopodes division of the molluscs, that "they have a brain inclosed in a distinct cavity; eyes; ears in the form of two mandibules; a tongue, salivary glands, an œsophagus, a throat, a second stomach, an intestinal canal, a liver, heart, arteries, veins, nerves, and the reproductive organs, in common with other vertebrated animals; but all differently disposed, and mostly organized in a different manner."—Bull. Univ. 1830, p. 310.

M. le Baron de Ferussac is preparing, and has begun to publish, his Histoire Naturelle des Mollusques, under the orders of the cephalopodes, pteropodes, and gasteropodes. It will be the completest work on the subject that has yet appeared.

lovely and the pleasing emane to us from the sprightly tenants of the trees and air, with more interesting effect than from the inhabitants of the seas. They produce this impression by so very different a modification of bodily configuration, that unless we had experienced it, we should not, beforehand, have thought that such total contrasts of external form could have been each made to produce such a similarity, though not equality, of gratifying result.*

It is in his kingdoms of animated nature that the magnificent and munificent Creator has shown us that beauty has as many forms and varieties as he chooses to display it in; that our intellectual faculty is trainable to an equal sensitivity of discerning and appreciating it; that his power of imagining and producing it is inexhaustible; and that he has purposely so arranged the material particles of our world, that this magical quality is perpetually appearing to our senses with an exuberant and ever-renewing profusion. Nor is it confined to living form. It appears likewise in every department of earthy and inorganic nature. All our knowledge and love of it arises from what has been created to affect us by its presence. Beauty is indeed everywhere about us; and every mind may be sensible of it, that will itself observe it where it exists. For our own sakes we ought to cherish a taste for it; for such are its soothing effects, that it cannot be anywhere seen and felt without a sensible pleasure accompanying the perception. It is therefore an easy and universal source of enjoyment to observe it, from which every class may derive, every day, many moments of gentle exhilaration. The bird classes partake of it so generally, in some respect or other, that the rudest minds become milder or happier from their presence, in all climes and in all ages.†

* There is great truth in the following sentiments:—"The main province, the very paradise of nature, is THE BIRDS. The gracefulness of their forms; the exquisite delicacy of their covering; the inimitable brilliancy of their colours; the light and life-giving transparency of the element in which they live; the singular variety of their habits; the delightful melody of their songs, and the remarkable fact, that with organs apparently more unfitted for articulation than many quadrupeds, they are the only animals that can imitate man in the wonders of voice, and rival him in the intricacy of music....These qualities make the study of birds the favourite study of every elegant mind."—Jerdan's *Lit. Gaz. No.* 672, p. 790.

† The unwearied and excellent ornithologist, who studied his favourite

The plumage of birds is peculiar to their order of creation, and is always a pleasurable object both to sight and touch, and remarkable for the skill and delicacy of its composition and structure. In the equatorial regions it is more rich and splendid in its colors, yet always harmonizing in its most contrasted tints, and in its lights and shades. The effect is sometimes gorgeous, but never tawdry. In all its combinations and lustres it gratifies the cultivated taste, and when extensively studied, enlarges the conceptions of the imagination by its elaborate diversity.

Birds also charm the ear as well as regale the sight; and thus satisfy both the most intellectual of our senses. The music and the beauty do not always unite in the same individual in equal excellence. Our nightingale and peacock are instances of the separation. In the Indian hemisphere, both attractions are frequently combined;* and in North America, the bird that is popularly called the Virginian nightingale is also styled the cardinal, from his brilliant red plumage;† although the one that actually rivals the poetic queen of rural melody is no more distinguished than herself in his personal appearance.‡

subject among the wilder tribes as well as in the civilized provinces of America, has left us this just observation of his large experience: "An intercourse with these little innocent warblers is favourable to delicacy of feeling and to sentiments of humanity; for I have observed the rudest and most savage softened into benevolence, while contemplating the interesting manners of these inoffensive little creatures."—Wilson, Amer. Ornithol. vol. ii. p. 240.

* "It is an error to say that nature has denied melody to the birds of hot climates, and formed them only to please the eye with their gaudy plumage. Ceylon abounds with birds equal in song to those of Europe, which warble among the leaves of trees, grotesque in their appearance, and often laden with the most delicious and salubrious fruit. Birds of the richest colours cross the glades; and troops of peacocks complete the charm of the scene, spreading their plumes to a sun that has ample powers to do them justice."... "An Indian forest is the most picturesque scene that can be imagined. The trees seem perfectly animated: the fantastic monkeys give life to the stronger branches; and the weaker sprays wave over your head, charged with vocal and various plumed inhabitants."—Penn. Ind. Zool. 45.

† The cardinal grosbeak of America, whose notes, Dr. Latham says, "are almost equal to those of the nightingale."... "Their notes are very various and musical: many of them resemble the high-notes of a fife, and are nearly as loud. They begin at the first appearance of dawn; and repeat a favourite stanza or passage twenty or thirty times successively. His sprightly figure and gaudy plumage; his vivacity, strength of voice, and actual variety of note; and the little expense with which he is kept, will always make him a favourite."—Wilson's Am. Orn. vol. ii. p. 274.

‡ "Our inimitable mocking-bird is acknowledged to be fully equal to

The birds of song abound in every known country; in the new continent, as much as in our older or longer inhabited one. But as they are seldom found in the depth of the dense and damp forests of any country, they are the more usual companions of civilized man.* They frequent most the cleared and cultivated plains, as if by kind appointment to increase the number of human pleasures, by warbling their own feelings and happiness in those melodies which delight the human ear as much as themselves. Neither childhood nor manhood can hear them with indifference. Their notes are everywhere a large addition to human gratification, and become connected with the sweetest remembrances of the most joyous and impressible season of our life. They are usually small birds, and seem to be indestructible; for although cultivation, as it spreads, drives off many other species, yet by supplying these with more of the food they like best, they multiply from its abundance; and wherever gardens, fields, or trees appear, some classes of these rural musicians are sure to be part of their feathered inhabitants. Of these, England possesses a pleasing share.†

the song of the nightingale in its whole compass."...."His plumage has nothing gaudy or brilliant in it. In his native groves, mounted on the top of a tall bush or half-grown tree, in the dawn of a dewy morning, while the woods are already vocal with a multitude of warblers, his admirable song rises pre-eminent over every competitor. The ear can listen to his music alone, to which that of all the others seems a mere accompaniment. His own native notes are bold and full; and varied seemingly beyond all limits. His expanded wings and tail glistening with white, and the buoyant gayety of his action, arresting the eye as his song most irresistibly does the ear, he sweeps round with enthusiastic ecstasy, and mounts or descends as his song swells or dies away."—Wilson, A. O. vol. ii. p. 92.

* "The opinion, that the music of the woods and groves of America is far inferior to that of Europe, I, who have a thousand times listened to both, cannot admit to be correct. We cannot with fairness draw a comparison between the depth of the forest in America and the cultivated fields of England; because it is a well-known fact that singing-birds seldom frequent the former in any country. But let the latter places be compared with the like situations in the United States, and the superiority of song would justly belong to the western continent."—Wilson, vol. ii. p. 275.

† The blackbird is the largest song-bird of England, and sings both spring and summer.—Albin's Nat. Hist. English Song-birds, p. 2.... The song-thrush warbles for nine months of the year.—P. 7.... The goldfinch is valued for the elegance of its colour as well as for its singing, as it is "the most beautiful and finest feathered of all cage birds."—P. 20.... The bullfinch, which combines a very pleasing form with a

Birds are distinguished from all other animals by their power of supporting such a weight as their bodies in a medium so light as air; and from which, by the laws of gravity alone, they would fall downwards like a stone, the instant they left their twig. They prevent this prone descent, and sustain their heavy bodies in an aerial fluid which is some hundred times lighter than these, and at the same time move through it more rapidly than any other class of animated beings can pass through it on the ground, by the amazing strength and moveability of their pectoral muscles, and by the expansile form and peculiar texture of their feathered wings. These muscles, the breast of the birds we eat, constitute half of the whole flesh of their body; and enable them to supply that quantity of the functional energy which actuates them to their action of flying.* Thus a moiety of all their nervous and muscular powers is exerted and expended in this operation.

Here again the most special and scientific calculation, with a specific adaptation, become manifest to our consideration. No blind force or random power or motion could have here availed. A deliberating and knowing mind must have been their creator, combining what we term mathematical and mechanical science. The bodies of every species of birds differ in weight and bulk. But in order that they may fly, and remain suspended in the air while they do so, the motive energies of each must be precisely proportioned to the two things so very dissimilar—to the gravity of his individual substance, and to the tenuity of the air through which he must glide and float. No general fitness would do; each distinct kind must have had allotted to

fine voice, has no song of its own, but excels most birds in that which he learns.—P. 16.....The linnet is thought by many to surpass all small birds in the sweetness of its singing.—P. 34.....The skylark has great freeness and strength in his notes, which are heard for at least eight months of the year.—P. 41,....But the woodlark is still more admired for his great variety of soft and delightful tones. He is also a bird of great beauty, both in shape and plumage.—P. 50.....The wren, although the smallest bird found in England, sings very sweetly for several months, and with a louder voice than we should expect from his little form. Whether upon a barn or tree in a farmer's yard (which they mostly frequent), or in a cage, they seem to sing with equal pleasure.—P. 70.....The common hedge-sparrow "is a very pleasant song-bird: he sings sweetly, and has a great variety of pretty notes."—P. 89.

* Borelli, de motu Anim. p. 260. He adds, that fish, having to move through a denser medium, have double this force,—*Ib.*

it a different degree, peculiar to itself, and exactly adjusted to the spread of its own frame, and to its gravitating tendency. These suited proportions must not only have been discerned and appointed to every one at its creation, but, as earthly races are perpetuated from parents, the foreseeing Power had also to form and regulate the oval embryos of every species, so as that each should continually reproduce the same adapted fitness of motive force, weight, and bulk. Such a patient condescension of almighty power and intelligence, deigning to apply so much thought and kind efficiency for the purpose of giving a multifarious variety to its creation, is far beyond our conception or panegyric. Yet it is an impressive testimony of his provident wisdom, acting for the instruction of his intelligent creatures. For it is this vast diversity which produces, by continual sensations in the human soul, and in every mind that can discern relations and reason to just inferences, such enlarged conceptions, and such a universal and continuing conviction of his active omnipotence. His power is by this means everywhere in visible picture before us.

Birds surpass all other animals in the faculty of continuing their motion without resting, as well as in its rapidity. The fleetest courser can scarcely ever run more than a mile in a minute, nor support that speed beyond five or six of such exertions. But the swallow does this for pleasure, for ten hours a day.* So can the blue-bird of America, for a space of six hundred miles, in the stages of his journey from Mexico to the territory of the United States.† Our carrier pigeons move with at least half that

* "It may fairly be questioned whether any birds pass over an equal extent of surface with the swallow. Let a person take his stand on a fine summer evening, by a new-mown field, meadow, or river shore, and among those of this tribe that flit before him, fix his eye on a particular one, and follow for a while all its circuitous labyrinths, its extensive sweeps, its sudden and reiterated zigzag excursions, little inferior to the lightning itself, and calculate the length of the various lines it describes. This little bird flies, in his usual way, at the rate of one mile in a minute, which, from the many experiments I have made, I believe to be within the truth; and he is so engaged for ten hours every day." —Wilson, Am. Orn. vol. ii. p. 39.

† "Nothing is more common in Pennsylvania than to see large flocks of these birds, in spring and fall, passing at considerable heights in the air, from the south in the former, from the north in the latter season. The Bermudas are said to be 600 miles from the nearest part of the continent. This may seem an extraordinary flight for so small a bird; but

celerity from our island to the Continent, and from one country to another.* The golden eagle is supposed to dart through the fiercest storm at the rate of forty miles an hour; but one of our smallest birds, the swift, can even quadruple the most excited quickness of the race-horse for a distance, and therefore, with a continuity of exertion, hardly within the bounds of our reasonable belief.†

One of the most special appointments of the Creator as to birds, and which nothing but his chosen design and corresponding ordainment can explain, is the law, that so many kinds shall migrate from one country to another, and most commonly at vast distances from each other.‡ They might have been all framed to breed, be born, live, and die in the same region, as occurs to some, and as quadrupeds and insects do. But he has chosen to make

it is a fact that it is performed. If we suppose the blue-bird to fly only at the rate of a mile a minute, which is less than I have actually ascertained them to do overland, ten or twelve hours would be sufficient to accomplish the journey."—Wilson, p. 178.

* Out of 110 pigeons brought from Brussels to London in the summer of 1830, and let fly from London on 19th July, at a quarter before nine A. M., one reached Antwerp, 186 miles' distance, at eighteen minutes past two, or in five and a half hours, being at the rate of nearly thirty-four miles an hour. Five more reached it within eight minutes after. Thirteen others took two and a half hours more for the journey, or eight hours in the whole. Yet this rate was twenty-three miles an hour.—Brussels papers, July 24.... Another went from London to Maestricht, 260 miles, in six hours and a quarter. In January, 1831, two pigeons, brought from Liskeard to London, were let fly back from London to Cornwall. One reached Liskeard, 220 miles' distance, in six hours; the other in a quarter of an hour more.

† Spallanzani thought that the little swift travelled at the rate of 250 miles an hour. Mr. G. White remarks that "the swift is almost continually on the wing, and never settles on the ground, trees, or roofs. It eats, drinks, and collects materials for its nest on the wing. It appears to live more in the air than any other bird, and to perform all functions there, save sleeping and incubation."—Nat. H. Selb. p. 218.

‡ M. Brehm, who has most elaborately examined this subject, states that every bird has its native country, where it freely reproduces, and remains a part of the year, and travels in the remainder. Most birds live half the year at their home, and pass the other half in travelling. Some travel by day, as the birds of prey; but the larger part by night. Some use both times. They seem to pass the whole of their migration without sleep; for all the day they are seeking their food. They stop in places that present this. They commonly keep very high in the air, and always at a suitable distance from the earth. Hence they rise higher over mountains, and fly lower along valleys. They require a wind that blows *against* them. A contrary wind assists and raises them. See his Treatise ably reviewed in Bull. Univ. 1830, vol. iv. p. 194-149.

them travel from one climate to another, with unerring precision, from an irresistible instinct, with a wonderful courage, with an untiring mobility, and in a right and never-failing direction. For this purpose, they cross oceans without fear, and with a persevering exertion that makes our most exhausting labours a comparative amusement.* Philosophy in vain endeavours to account for the extraordinary phenomenon. It cannot discover any adequate physical reason.† Warmer temperatures are not essentially necessary to incubation, nor always the object of the emigration; for the snow bunting, though a bird of song, goes into the frozen zone to breed, lay, and nurture its young.‡ The snow-bird has the same taste or constitution for the chilling weather, which the majority recede from.§

* In general, in Europe, the birds take a S. W. direction in autumn, and a N. E. in spring. There is no doubt that they pass over the ocean. Faber saw one in the middle of its route between Denmark and Iceland. A regulus was taken in the middle of the Baltic Sea. The quails, whose wings are so small, cross the Mediterranean. They wait whole weeks for a favourable wind, reposing on every small isle. Hence they are taken by thousands on the Ionian Isles and coast of Asia. Should the wind change rapidly, a great number perish in the sea. Humboldt observed some mallards and herons some degrees N. of the equator, passing the line, and going south.—Brehm, *ib.*

† "What decides birds to emigrate? It is not want of nourishment, for most begin the journey while they have abundance. Those confined in cages are very restless at the time of their proper migration. Atmospherical currents are not the cause; nor do the changes of season explain it; as the greatest number set off while the weather is yet fine; and others, as the larks and starlings, arrive while the season is bad. Atmospherical influences can only hasten the migration in autumn, or retard or derange it in spring. It is the *presentiment* of what is to happen which determines birds to begin their journey. It is an instinct which urges them, and which initiates them into the meteoric alterations that are preparing. They have a particular faculty of foreseeing the rigour of the coming season; an exquisite sensibility for atmospherical changes, which have not yet arrived, but are approaching."—Brehm, *ib*.... See also Esktroem's Observations, in Bull. Un. 1829, p. 111.

‡ Mr. Pennant says, that "these birds inhabit not only Greenland, but even the dreadful climate of Spitzbergen, where vegetation is nearly extinct, and scarcely any but cryptogamious plants appear. Yet they are found in great flocks both on the land and ice of Spitzbergen. That they breed here is very probable; but we are assured that they do so in Greenland. They arrive there in April, and make their nests in the fissures of the rocks in May."...."They seem to make the countries within the whole arctic circle their summer residence, from whence they overflow the more southern countries at the setting in of winter in the frigid zone. They sing finely near their nests."—Wilson, vol. ii. p. 223.

§ The snow-bird in America, "in April, when the weather begins

We can only resolve all these astonishing journey into the appointment of the Creator, who has assigned to every bird the habits, as well as the form, which it was his good pleasure to imagine and to attach to it.* The watchful naturalist may hear, if not see, several migrations of those which frequent our island, both to and fro, as spring advances and as autumn declines; but as they take place chiefly in the night or at an early dawn, and in the higher regions of the atmosphere, they are much oftener audible than visible to us on the surface of the earth.†

The quantity of individuals of the various bird genera, which are at any one time and at all times existing in our world, surpasses not only our usual supposition, but even all power of human numeration, at least as to any real, distinct conception of the amount; for we can only pen down the words millions, billions, trillions, quadrillions, and such other augmentative terms, in which all actual comprehension soon becomes lost in mere verbal sounds and confusing obscurity. It will therefore be better to particularize in a note a few instances of what was seen at only four points of our globe, and leave it to your own mind to infer from these, what unaccountable myriads of

to be warm, retires northward, arrives about the Hudson Bay factory in June, and proceeds *farther north* to breed."—*Ib.* 258.... This species is so numerous, that Mr. Wilson mentions, "In the circuitous route I travelled, of more than 1800 miles, I never passed a day, and scarcely a mile, without seeing numbers of these birds, and frequently large flocks of several thousands."—P. 257....The killdeer plover likewise "seeks the more remote arctic regions of the continent to breed in."—*Ib.* vol. iii. p. 12.

* So the Jewish prophet represents and applies it—"The stork in the heaven knoweth her appointed times; and the turtle and the crane and the swallow observe the period of their coming. But my people will not know the judgment of Jehovah."—Jer. viii. ver. 7.

† In October, 1829, movements of this sort in Berkshire were thus described: "We have had sharp night frosts during the week, and large flights of plover; and teams of wild duck and geese have passed hence in a northern direction. On Wednesday morning last, the roofs of all the higher ranges of houses in Prospect-street in this town were covered with thousands of the SWALLOW tribe, which had then assembled preparatory to their annual migration to a warmer climate. From their chirping and fluttering about, they *seemed* to be in grand *debate:* and about nine o'clock the larger division *departed* in a S. W. direction, and was afterward *followed* by the others. The morning was remarkably fine and cheering; and the interesting little emigrants were pluming their wings soon after sunrise, preparing, as it were, for their long voyage, and still dubious destination."—Berks Chron.

millions, in all the classes of the feathered race, must have been elsewhere then existing, and are now pervading both our aerial and vegetable domains.*

This surprising quantity of birds makes it necessary that the insect world, on which all the smaller feed, should be a thousand times more numerous. The two millions of starlings usually resident in the United States of America have been computed to consume of the grub-worms, caterpillars, and other larvæ, on which they subsist, in the four months of their breeding and nurturing their young, sixteen thousand two hundred millions.† But if a single kind of birds have this supply, all the other classes who use the same nutriment require as much. It is obviously impossible to enumerate the amount of the individual living creatures which are always existing on our globe, and partaking of its produce in some way or other. Yet so admirably are the whole placed and disposed, and the size and movements of each so carefully regulated and adapted to us and to each other, that we are neither disturbed by the number,

* The *purple gracula* of Pennsylvania, when they collect to migrate to the lower parts of Virginia, Carolina, and Georgia, "sometimes form one congregated multitude of *many hundred thousands*."—Wilson, Am. Or. vol. i. p. 219.

Captain Flinders, on his voyage, saw "a stream of stormy PETRELS, which was from 50 to 80 yards deep, and 300 yards or more broad. The birds were not scattered, but flying as compactly as the full movement of their wings seemed to allow: and this stream of petrels, for a full hour and a half, continued to pass without intermission at a rate little inferior to the swiftness of the pigeon. Now, taking the stratum at 50 yards deep by 300 in breadth, and that it moved 30 miles an hour; and allowing nine cubic inches of space to each bird,—the number would amount to 151 millions and a half."—Flinders' Voyage.

An officer who visited South Shetland, in the antarctic regions, states that he saw there many millions of "PENGUINS. The ground in some parts is covered to the extent of two or three miles with these birds."—Letter in Lit. Gaz. 31 Oct. 1829.

The migratory PIGEON, in the United States, exhibits a number still more enormous. "Of one of these immense flocks, let us attempt to calculate the numbers, as seen in passing between Frankfort (on the Kentucky) and the Indiana territory. If we suppose this column to have been one mile in breadth, and I believe it to have been much more, and that it moved at the rate of one mile a minute, four hours, the time it continued passing, would make the whole length 240 miles. Again, supposing that each square yard of this moving body comprehended three pigeons, the square yards multiplied by 3 would give 2,230 millions 272 thousand pigeons; an almost inconceivable multitude, yet probably far below the actual amount."—Wilson's Am. Orn. vol. ii. p. 299,

† Wilson's Am. Orn. vol. i. p. 198.

nor even conscious of it. There is no crowding; no confusion: the enormous amount is nowhere visible to our sense. We must search it out, in order to know it. We must calculate from what we can observe, before we can perceive or believe the ever-palpable but unobtrusive truth. What but an allmighty and all-adjusting sagacity, infinitely beyond the highest expansions of human genius, could have arranged such inexpressible multitudes of living, sentient, and ever moving beings, into positions, limitations, and habits so wisely appropriated to each, so productive of comfort to every one, and yet so conservative of the harmony, the order, and the general welfare of the immense and multiform whole!

As we contemplate such endless masses of living things, we are sometimes tempted to ask, Why so many? Why such an exuberance of creation? My own reason answers, to its private satisfaction, and from its own feeling —the gift of life, for whatever space, small or great, is a gift which Deity alone can give; which is his noblest donation; and which, being attended with comfort as its universal law and most general result, is the greatest blessing that any creature can receive. All other blessings may be added to it; but none can be enjoyed without it. The more largely it is given, the more extended is the benefaction; and therefore every multiplication of it becomes an ampler display of the magnificent and illimitable benevolence of its bestower. The greater the multiplicity of his kind creations, the more certainty my sense and judgment perceive of his gracious, generous, and affectionate nature. He loves to make living beings of every sort and form, and to provide for their pleasurable enjoyment of the life he gives. The occasional interruptions of pain to any, are but exceptions, unavoidable in such a profusion of varied existence; always bear but a small proportion to their comfort; and are usually made conducive to good in some respect or other. It is only wonderful that the gratifications of each, in such diversified multitudes, so little clash together; and that these, amid such a universal desire and active search for their distinct and peculiar enjoyments, should so rarely give pain to each other. As Paley has most justly said, "Pain is nowhere the object of creation;" it is the temporary accident, but not the ruling law.

But the multiplicity of creation not only manifests its great Author's benevolence, but it is that which gives us—and perhaps is that alone which could give us—a sensorial idea of his actual omnipotence. Mind, in any one, can only make itself visible to others by its works and actions. So must all power, and all moral and intellectual qualities. The living figure of a Homer, a Milton, a Raphael, or a Newton could not reveal to us, by its presence alone, either of their intellectual productibilities. Each had to put these into action in making external things that would display them, before others could know their admirable talents. So the Divine Creator makes his inexhaustible potentialities more and more sensible to us, the more he varies and multiplies his creations. Every increase enlarges our conceptions of his powers, by presenting additional sensations to our visual organs of its self-displaying effects.

All birds are oviparous. This is their law of reproduction: none bring forth live ones. Their eggs vary in number, size, and colour, but are always covered with a calcareous shell, the produce of their own living functions.* These are deposited by them in an artificial nest of their own construction, and are hatched by the genial warmth of the maternal body. In their natural state, birds are mostly monogamous, or live in single pairs. They migrate into milder climates, and a few become torpid in winter. Their feathers are disposed over each other in the form of a quincunx, in which those of one row are opposite to the intervals of the next; and vary in colour, according to age, sex, season, or climate, except the quill and tail-feathers. These are more constant, and chiefly characterize the species.†

Linnæus divided them into six orders, and took his gene-

* Vauquelin and Dr. Prout have made many experiments on the shells of the eggs of fowls; ascertaining the exact quantity of earthy matter they contained; analyzing the food received, and nothing what was ejected. The results appeared to indicate that the animal had acquired a greater quantity of earthy matter than could be accounted for, except by supposing that, in some way, a portion of it had been developed by the vital powers.—Dr. Bostock, Elem. Phys. vol. ii. p. 386.

† Turt. Linnæus, vol. i. p. 131. "This beautiful and cheerful portion of created nature consists of animals having a body covered with feathers and down, jaws protracted and naked, two wings formed for flight, and two feet. They are aerial, vocal, swift, and light. They are destitute of external ears, lips, teeth, bladder, epiglottis, corpus callosum, its arch, and of a diaphragm."

the characters from their bill, tongue, nostrils, caruncles, and other naked parts. To these, Dr. Latham has discriminatingly added three other orders, by which their distinguishing arrangement was much improved.* The Prince Charles Lucien Bonaparte, following the steps of the self-taught naturalists, Wilson and Audebon, the American ornithologists, is now enlarging and completing it.†

Of all the vertebrated or superior animals, birds seem to have the shortest lives; yet some kinds outlive by far the age of man.‡ But those most familiar to us, and the greater number of all the genera, resemble in their duration that of our domesticated animals.§ Their feathers are highly electrical. The food of the larger number is chiefly seeds, worms, and insects, and sometimes they use earth and stones. Their songs are usually in the day time; but a few make the night more interesting by their melody.‖

* There were—I. Accipitres.—II. Picæ.—III. Anseres.—IV. Grallæ.—V. Gallenæ.—VI. Passeres.—Linn. 132....As altered by Dr. Latham, the nine orders are thus represented:—

I. Accipitres, or rapacious birds.
II. Picæ, or Pies.
III. Palmipedes, or web-footed; answering to the anseres of Linnæus.
IV. Pinnatipedes, or fin-footed.
V. Grallæ, or waders.
VI. Gallenæ, or poultry.
VII. Struthiones.
VIII. Passeres.
IX. Columbæ, pigeons or doves.

The gallenæ include our game. The struthiones are the dodo, touegal, cassowary, and ostrich. The passeres comprise our sparrow, swallow, thrush, lark, wagtail, and other small birds.—Kerr's Linn. 418-428.

† The prince's remarks show the progress of this branch of our knowledge:—"Buffon complained of the difficulty of writing a history of birds because he already knew 800 species, and supposed that there might actually exist 1500 or even 2000; what would be his embarrassment now, when nearly 6000 species are known, and fresh discoveries are daily augmenting the number!"—Am. Orn. vol. iv. p. 1.

‡ Count Morozzo, in his letter to La Cepede, states, that the swan will live about 200 years; the crow and raven, 100; the parrot, 100; the goose, 80....Schultz, in his notes on Aristotle's animals, mentions a parrot, carried from Italy to France in 1633, which was living there in 1743, being then 110 years old.

§ The peacock, 25 to 28 years; pheasant, 18 to 20; nightingale 17 or 18; the hen and pigeon, 16 or 17; the linnet and canary, 13 or 14. Co. Mor....The goldfinch, 20 to 23 years; the skylark, 15 or 20. Albin. Nat. Hist. p. 22, 41.

‖ Besides the nightingale, the rose-breasted grosbeak of America has this habit. "One of these birds, kept in a cage, frequently sang at night, and all night; its notes were extremely clear and mellow, and the

Some have utterances of voice like animal sounds;* and several can be taught to imitate human articulation, and to repeat words in any language.† But this is not the only analogy which unites them with ourselves. All the classes of animated nature exhibit occasional intimations that one grand system of formation is pursued through all the varieties of animal organization. The human countenance, and the brutal physiognomy, are each convertible into partial resemblances, which show that both are but diversified, though constantly maintained, modifications of the same great plan and principle of structure. The wing, the arm, the fore-leg, and the pectoral fins are instances of the variations of one important limb; and therefore, though it is a very rare occurrence, yet it is no natural impossibility, that a fowl's head may sometimes appear with an obscure similitude to a human face.‡

The birds are a race of organized beings, as happy as they are beautiful: their greatest number are peaceful,

sweetest of any bird with which the owner was acquainted."—*Wilson*, vol. ii. p. 277.

* Thus the titmouse "whistles aloud and clearly, as if calling a dog."—Wilson, ii, p. 217....The catbird's note so exactly resembles the voice of a kitten, that a stranger to it would instantly conclude that such an animal "had got bewildered in the branches."—P. 100....The cry of one species of plover is the repetition of the word "Kill-deer."—*Ib.* vol. iii. p. 9.

† The bullfinch can be taught to speak several words at command. Albin, p. 16....The starling is very apt to imitate the human voice.—*Ib.* 12....The magpie, jay, parrot, and some others are well known to have a facility of acquiring such articulations.

‡ M. Cuvier states, that in 1802 a Jew exhibited for money, at Posen, in Poland, a hen with a human face, which had been hatched in a farm near Wrycenien. He says,

"I have *myself* seen this animal alive, and in excellent health. It had attained its full size, for it was more than a year old. In its body it resembled other hens in every respect except the *head*. This was of the usual size, but *without* feathers, and covered with a bluish skin. The cavities of the *eyes* were completely formed *like* those of the human eyes. They were surmounted by two small arches of down, which formed very *regular eyebrows*. The upper part of the bill was shorter than usual. It had but one blunted point, and the *nostrils* were underneath it; so that, although it was *horn*, it presented the perfect resemblance of a very well made nose. Below this nose was a very regular mouth, with lips, two *rows* of very white teeth, close and pointed, and a *rounded* tongue. This resemblance to a human countenance had something in it even horrid; but it was perfect, and had no need of the assistance of imagination to be recognised."—Cuvier's Animal Kingdom.

friendly, social, innocent, and contented. The rapacious class, and some of the aquatic species, present a predatory anomaly; but the exuberant multitudes of their most prolific classes are of a kind, harmless, active, and neighbourly character. They seem to have a pleasure in being together in some mode or other.* It is very interesting to observe the social and family feelings of many species. The rural naturalist has pleasingly described several instances of what resembles the conduct to which, among mankind, we annex the terms attachment and affection.† Nor are these feel

* "With the exception of our birds of prey, and a few others, all the feathered tribe seem to have a general tendency towards association, either in flocks, or family parties, or pairs. The woodlark does not unite in companies, but it associates in its own little family parties."—Knapp's Journ. Natur. p. 258, 269.... From Van Dieman's Land, a gentleman writes: "In the woods, the parrots and parroquets are social, and almost tame. I have had, at one time, fifty flying around me, sparkling in the sunbeams like so many gems." In Pennsylvania, the goldfinches "associate in flocks; frequently assembling in great numbers on the *same* tree, to bask and dress themselves in the morning sun, singing *in concert*, for half an hour together."—Wilson, ii. p. 263. The titmouse species, "associate in parties of six, eight, or more, attended by the Carolina nuthatch, the brown creeper, and small spotted woodpecker; the whole forming a very nimble and restless company, whose food, manners, and dispositions are very much alike."—*Ib.* 215.... So the tree and song sparrows unite in flocks, and form societies with other birds.—252, 254.

† "The linnet delights and lives in society, frequenting open commons and gorsy fields. Several pairs, without the least rivalry or contention, build their nests and rear their offspring in the same neighbourhood. They form large associations, feeding and moving in company, as one united household. Resorting to the head of some sunny tree, they will pass hours in the enjoyment of the warmth, chattering with each other in low and gentle notes."—Knapp's Journ. 158.

"The jay and its family associate, during all the autumn and winter months, taking great delight in each other's company. They separate only to become the founders of new establishments."—*Ib.* 191.

"Delight in society is a predominant character in starlings. To feed, they will associate with the rook, the pigeon, or the daw: but they chiefly roost with their own families. These social birds are rarely seen alone. Should any accident separate an individual from the companions of its flight, it will sit disconsolate on an eminence, piping and plaining, till some one of its congeners joins it. Even in small parties, they keep continually calling and inviting associates to them with a fine clear tone. They vastly delight, in a bright autumnal morning, to sit basking and pruning themselves on the summit of a tree, chattering all together in a low, song-like note."...."They are very assiduous in their attentions to their young."—*Ib.* 200.

"Rooks appear to associate from preference to society, as trees are common everywhere."—P. 188.

ngs confined to the milder birds. Even vultures are gregarious, and exhibit pleasure in each other's society.*

To delineate the instincts, the feelings, and habits of the feathered kingdom is no part of my present intention. There is as much of what resembles intellectual sensibilities and reasoning, will and judgment, in them, as in any genus of fish or quadrupeds. This analogy may even be extended to ourselves. At least, I cannot but admit the application of it to such qualities in myself. I have frequently surveyed the various poultry and the birds that frequent the fields and gardens around me, with these considerations. If I could transfer my own mind, divested of all the human knowledge it has acquired, but with its natural faculties unimpaired, into the body of any fowl about, and could give to it the ideas and memory which their organs and habits have acquired—should I, in the exercise of my judgment on such sensations as theirs, act otherwise than as they do under the circumstances in which they are placed and live? When I have put the question to myself, I have not been able to discern that I should, in their bodies and condition, conduct myself very differently from them. They seem to do all the things they ought; and to act with what may be called a steady common sense in their respective situations. I have never seen a bird do a foolish thing, for a creature of their powers, frame, and organs, and in their state. Each acts with a uniform propriety; no thing fantastic, absurd, inconsistent, maniacal, or contradictory appears in their simple habits or daily conduct. They seem to have mental faculties and feelings like mine, up to a certain extent; but to that they are limited. They have not the universality, the diversifying capacity, nor the improvability of the human intellect. The bird mind is the same bird mind from generation to generation. The nightingale is now what the nightingale was four and six thou-

* M. Audebon mentions that "they often associate in flocks of 20, 40, or more; hunting thus together, they fly in sight of each other. The moment a prey is discovered, the favoured bird gives notice to its nearest companion, who immediately follows him, and is successively attended by all the rest."—Am. Orn. iv. p. 251. . . . With two young vultures that he had reared, he put in an old one that he caught. "The young both at once jumped about him, making most extraordinary gestures of welcome."—P. 250. . . . His experiments show that vultures discern their dead spoil not by smell, but by sight.—247-59.

sand years ago—nothing less, nothing more. The eagle is as incapable of advancement as the sparrow. The common fowl, which is found in all regions and climates of the globe, is in each one exactly alike in its functions, faculties, and habits. The song-birds warble now just as they have done ever since human history has noticed them. It is this confining identity which separates birds and all animals so widely from man. They never improve; while his capability of progression is as yet illimitable, and may perhaps ever be so.

Yet the bird mind, although thus limited, displays all the common faculties of animal intellect. Its memory is tenacious. The bullfinch never forgets the songs he has learned, though placed amid many others with different melodies.* Most of the singing-birds may be taught the notes of others, and to pipe and whistle as their instructer pleases.† Their aptness to acquire little acts of exhibition shows attention, comprehension, docility, and recollection.‡ Some exhibit a taste for the little gratifications of human vanity;§ others, a spontaneous intellectual observation and perception of the intention of human actions.‖ Even the highly mental emotion of emulation is visible among them.¶ The

* Albin. Nat. Hist. p. 16.

† The starling learns to whistle tunes.—Alb. 12. So the blackbird.—P. 2. The goldfinch will acquire a canary's or woodlark's song.—P. 24. The linnet, besides its own sweet song, will learn others.—P. 34. The robin, from the nest, may be taught to pipe or whistle finely.—P. 65. So the greenfinch.—31.

‡ The greenfinch will learn to ring bells in a contrived cage.—Alb. p. 31. And a goldfinch may be trained to draw water or food in a small ivory bucket, fastened to a chain; open it, take out its contents, and return it for more.—*Ib.* 21.

§ Goldfinches "are delighted with viewing themselves in a glass fixed to the back of their bucket-board, where they will sit upon their perch, pruning and dressing themselves with the greatest care, often looking in the glass, and placing every feather in the nicest order."—Albin. p. 22.

‖ The painted bunting is very fond of flies. Six of them were in a ship on a voyage to New-Orleans. Several of the passengers caught flies to give them, "till at length the birds became so well acquainted with this, that *as soon* as they perceived any of the people attempting to catch the insects, they assembled at the front of the cage, stretching out their heads through the wires with eager expectation, evidently much interested in the issue of the efforts."—Wilson, vol. ii. p. 240.

¶ "If the woodlark be hung in the same room with the nightingale he will strive with it for the mastery; as likewise it sometimes happens in the woods, where is a strong contention between these two choristers to excel and outdo each other. If brought up from the nest, and caged

perception, that their eggs in hatching should have a proper degree of heat, and the alternate movement of them for that purpose displays both a right reasoning and acting rightly on it.* Nor are they sometimes destitute of animal or human pugnacity. We expect this in the game birds that can be trained to it; but even the more gentle and peaceable can sometimes exert the petulant irritability.† But it is in their nests that they display the most striking and varied indications of contriving and judging, and therefore of thinking intellect, confined indeed in the extent of its operations, but resembling reasoning intellect within this compass.‡ Their affection for their young, their anxious

in the same room with a nightingale, he will learn its notes, and incorporate them with its own."—Albin. p. 50. . . . "Each strives to outvie the other; so that, like true-bred game cocks, they seem resolved to die rather than lose the victory. If the nightingale carries it in stoutness and fierceness of song, so does the woodlark in his pleasing variety of soft, warbling, harmonious note."—*Ib.* 73. . . . Handel has admirably imitated both these competitors, in the "Mirth! admit me of thy crew;" and in the "Sweet bird, who shunnest the noise of folly;" of his Allegro and Penseroso.

* "Almost all birds are in the habit, while sitting, of *changing* the eggs from the centre to the circumference, and *vice versâ*, that all of them may receive an equal share of warmth."—Jameson's Note to Wilson, vol. i. p. 215.

† "The males of the cardinal grosbeak, when confined together in a cage, fight violently."—Wilson, vol. iii. p. 276. . . . The pinnated grouse "seem to vie with each other in stateliness; and as they pass each other, frequently cast looks of insult, and utter notes of defiance." These are the signals for battles, and they engage with wonderful spirit and fierceness.—*Ib.* 337. . . . One of the titmouse species "sometimes fight violently with each other, always directing their blows against the scull."—*Ib.* 216. . . . Even the beautiful humming bird, as he passes from flower to flower, will at peculiar seasons attempt a contest. "When two males meet at the same bush or flower a battle instantly takes place; and the combatants ascend in the air, chirping, darting, and circling round each other, till the eye is no longer able to follow them."—*Ib.* p. 209.

‡ The oriole forms his nest of long and flexible grass, which is knitted or sewed through-and-through in a thousand directions, as if done by a needle; which made a lady inquire if it could not be taught to darn stockings.—Wilson, vol. i. p. 189. . . . The Baltimore-bird, seeking materials for his nest, when the women hang out their thread to bleach, perceives that this will suit him, and carries it off. "Skeins of silk and hanks of thread have been often found hanging round his nest; but so woven up and entangled as to be irreclaimable."—Wilson, vol. i. p. 180.

"The birds of the Indian climates are obliged to exert unusual artifice in placing their little broods out of the reach of an invader. Each aims at the same end, though by different means. Some form their pensile nest in the shape of a purse, deep, and open at the top; others with a hole in the side; and others, still more cautious, with an entrance at the

contrivances to protect them, and little stratagems to mislead the marauder from their nests, evince feelings and mental activities analogous to those of other reasoning beings.*

LETTER XIII.

The Formation of Quadrupeds—Their Linnæan Classification into Orders and Genera—Their general Qualities—Number—Food—Organs of Sense, Voice, and Feelings.

The sixth stage or day of creation began with the formation of quadrupeds, insects, and reptiles, which completed the animals that inhabit our globe. These were, like the preceding, so many other incorporations of the living principle and animal mind in three distinct and very different systems of organized matter. Each were also peculiar conceptions and inventions of the Deity, both in external figure and in physical powers. These were so many new effusions and display of his rich and multiform imagination. The structure, appearance, functions, and

very bottom, forming their lodge at the summit."—Pennant's Ind. Zool. 46.....This instinct prevails also among the birds on the banks of the Gambia, which abound with monkeys and snakes. Others, for the same end, make their nest in the holes of the banks that overhang that river.—Purchas, vol. ii. p. 1576.

"The lesser species, having a certain prescience of the dangers that surround them, and of their own weakness, suspend their nests at the extreme branches of the trees. They are conscious of inhabiting a climate replete with enemies to them and their young; with snakes that twine up the bodies of the trees; and apes that are perpetually in search of prey: but, Heaven-instructed, they elude the gliding of the one and the activity of the other."—Penn. Ind. Zool. p. 44.

The motacilla sutoria, the tailor-bird, "will not trust its nest even to the extremity of a slender twig, but makes one more advance to safety, by fixing itself to the leaf itself. It picks up a dead leaf, and *sews it* to the side of a living one; its slender bill being its needle, and its thread some fine fibres. The lining is feathers, gossamer, and down. The bird, in colour a light yellow, is but three inches long, and its weight only three-sixteenths of an ounce. A nest of this kind is in the British Museum."—Penn. Ind. Zool. p. 46.

* See Wilson, vol. ii. pp. 93, 230, 250, 310, 317; and vol. iii. p. 4; and in many other places.

organizations of each had to be designed, and the means of producing them to be perceived and put in action. The whole plan having been fully settled, the mandate was given for their simultaneous existence; and all the three very dissimilar orders of animal being arose obediently to the command, as their material elements moved into the appointed combinations and dispositions which were to constitute their respective bodies.

The quadrupeds were those with which the pleasure, he sustenance, and the convenience of man are more immediately concerned. None are indispensable to him, as he can subsist without either; but he derives such important benefits from all these three classes, that it is rational to suppose, that one of the main ends of their creation was to contribute, in some of their species, to his comfort and service. Nothing can be supposed to have been exclusively formed for our use; but several were manifestly made that this application of their powers and qualities might take place. Each exists for its own benefit, as well as for that of others, or for ours; but many have been designed on purpose to be also instrumental to our convenience and improvement.

A natural division of quadrupeds would be into the fierce and the gentle,—the wild and the tame,—the carnivorous and those which feed on herbs and grasses. Such a distinction exists in all the orders of animal life. Fish, birds, beasts, insects, and reptiles have each a predatory and a peaceful class; the latter always the most numerous,—the former confined to particular objects of pursuit, but always now appearing as an inseparable part of the economy of our varied world in its present state. Yet, as geology teaches us that the present was not our earth's primeval state, it has been confessedly altered in its planetary, rocky, animal, and vegetable relations and substances, and in its life-connected caloric—we have no right to affirm that the predatory tendency was the primitive law, or that either animals or man were, in their first condition, carnivorous. Their structure was prepared for it as their most lasting state, but can live in other habits. Carnivorous animals, notwithstanding their adapted teeth, claws, and intestines, may be brought up on vegetable produce: as man can subsist wholly on plants, or wholly on flesh, as he chooses.

The prophetic writers of the Old Testament indicate that this destructive anomaly is not to be perpetual. In the last ages of earthly being, when wars and vices, sin and evil, are to depart from human society, the predatory system is also to cease in all the animal kingdom. It may therefore have some connexion with human immorality and its disturbing consequences, and with the new moral economy that was established after the deluge. But putting aside for the present this curious subject of our more difficult contemplations, it is sufficient to know, that at least from the time of the diluvian catastrophe to the age we live in, the quadrupeds of the earth have been in these two grand divisions, of the fierce or wild, who are all carnivorous—and of the gentler, the tame, and the domesticated, which are mostly graminivorous. Perhaps originally all of this class were so; for our cat and dog are rather two species of the wild, tamed into the gentle, than original natives of the pacific genera. The frame of each kind now corresponds with its present habits.

Linnæus has distinguished the quadrupeds of the earth into six orders, and added another for the cetaceous fishes; with the general term of MAMMALIA for all, because they have all been created with the peculiar habit of nurturing their offspring in a manner similar to the human race.* These seven orders, subdivided into forty-eight genera, include above eight hundred species. The characters of the orders were taken by Linnæus from the number, situation, and structure of the teeth.*

"The mammalia are such animals as nourish their young by means of milky teats or paps. In their structure

* These orders are—I. Primates; II. Bruta; III. Feræ; IV. Glires; V. Pecora; VI. Belluæ; VII. Cete.—Turt. Linn. i p. 4–6.

† The genera of the mammalia are—

I. Man, ape, macauco, and bat.

II. The sloth, anteater, manis, armadillo, rhinoceros, sukotyro, elephant, walrus.

III. Seal, dog, cat, fitchet, weasel (comprising otters), bear, opossum, mole, shrew, urchin.

IV. Porcupine, cavy, beaver, rats and mice, marmot, squirrel, dormouse, jerboa, hare, ashkoko.

V. Camel, musk, deer, giraffe, antelope, goat, sheep, ox.

VI. Horse, hippopotamus, tapir, hog.

VII. Narval, whale, cachalot, dolphin.—Kerr's Linn. 31–33.

Later naturalists have made some additions and modifications.

and various organs, they resemble man. They are for the most part quadrupeds, or having four legs and feet. Along with us, they inhabit the surface of the earth. The largest in size, though by far the smallest in number, are furnished with fins, and inhabit the ocean."*

The clothing of quadrupeds distinguishes them from the other orders of created beings. It is composed of soft, separate, flexible hair, little subject to injury, which is more plentifully bestowed on the inhabitants of cold regions than on those which live in the warmer parts of the earth. "This hair coalesces together on urchins and porcupines, to form spines or prickles. These are flattened on the manis into sharp pointed scales; and are united into a shelly coat on the armadillo. The fur is often divided by distinct ridges, as in the dog and horse; and these, on the horse and hog, are sometimes elongated into a mane. In aquatic quadrupeds the hair is altogether wanting, lest it should absorb the wet, except in such as are sometimes obliged to live on shore. The face of animals is frequently furnished with bristly warts; the lips with whiskers; the chin, as with man, apes, and goats, with a beard. The legs and breast, as in the hare and camel, are often provided with callosities."† For the most part, their connubial association is transient, and often periodical. A very small number, as some apes, the macauco, the bat, and urchin pair together; a single male and female entering into a monogamous society, and rearing their young ones by a joint concern.‡

The number of quadrupeds at all times on the earth is, as of the other kinds of animals, marvellously great, and exceeds the possibilities of human observation or enumeration. Of the eight hundred or thousand individual species which are now simultaneously existing, many are very prolific; but in those which we domesticate, and which moderately multiply, the quantity is very large.§ What we

* Kerr's Linn. p. 33. † *Ib.* ‡ *Ib.* p. 36.

§ To instance only in the SHEEP; France feeds 34 millions of sheep; and Great Britain and Ireland, 44 millions; Prussia, in 1825, had nearly 12 millions; Austria, in 1815, nearly 11 millions; and Hungary 8 millions; Spain, in 1803, had 12 millions; the Confederated Provinces of Germany, in 1820, had 20 millions.—Bull. Univ. 1827, p. 98; 1830, p. 306, 365. Thus these seven countries of Europe possess 141 millions of these animals only.

rear, we principally consume for food. But we may enlarge our conceptions of the general amount, by adverting to the number that in one province only of Europe were destroyed in a single year by one tribe of its predatory animals.* Similar inferences may be made from those, which individual activity can obtain when stimulated to take them.† If the law of their serving for subsistence to others had not been placed in nature coincident with the law of reproduction, the power of the latter would have soon overwhelmed the globe with its astonishing exuberance ;‡ but the weaker animals can sometimes protect themselves from the fierce and powerful.§

The animals in the first Linnæan order usually feed on herbs, fruits, and roots ; a few take insects, eggs, and small

* The public papers, in 1825, printed the following official account of the devastations committed by WOLVES in the government of Livonia, in the year 1823. They were stated to have devoured 1841 horses, 1243 foals, 1807 horned cattle, 733 calves, 15,182 sheep, 726 lambs, 2545 goats, 283 kids, 4190 swine, 312 sucking pigs, 703 dogs, 673 geese. We may therefore thank our Anglo-Saxon king Edgar, and Edward I. for so liberally rewarding those who were active in exterminating this animal from England and Wales. We may rejoice the more at our complete extirpation of them, when we find that in the last two winters they made very serious depredations even in highly civilized France, although it has such an active population to apply to their destruction. It is true that its mountainous borders favour their perpetuation ; yet, with such means and such a people, these ravages upon it are a sort of reproach to its political benevolence.

† In three weeks, Buffon caught, on 16 acres, 1300 moles ; and a Dutch farmer, in 1742, between 5 and 6000. In 1749 the state of Pennsylvania paid for the killing in it of 640,000 squirrels ; and at Gotha, in one year, 80,000 Hamster rats were killed and paid for.—Bingl. An. Biog. i. p. 302 ; ii. p. 31—39.... In the Isle de France, in 1826, the sugar-cane being infested by rats, and the rice by birds, the governor offered a reward for their destruction. In *one month*, eight arrondissements of the island sent to him 830,473 rats' tails and 938,549 birds' heads to be paid for. —Revue Encycl. Jan. 1827.

‡ It has been remarked that rabbits breed several times a year, and commonly seven or eight at a time ; so that in four years one pair might be ancestors of a million.—Bingl. ii. p. 53.... Brown rats have produced 20 at a litter, and three times a year. At this rate a pair might in two years produce a million.—P. 19.... A Guinea pig breeds every two months, and has usually three or four. So that from a single pair 1000 might come in a year.—P. 53. These would multiply proportionally, and soon overrun any country if not consumed.

§ In India, a tiger broke into a shed, where a colt and pony were sheltered. As he killed the colt, the pony attacked him with its heels, and so repeatedly struck his head and ribs as to knock out some of his teeth, and so bruised and cowed him, that he crawled off to a nullah hard by, where the natives despatched him.—Indian Gazette, 1827

birds;* and the bats seek moths, gnats, and nocturnal insects. Some of the bruta consume insects and worms;† but the great body, among which are the rhinoceros and the elephant, live on vegetables.‡ The feræ are carnivorous.§ The glires, or mice kind, generally subsist on vegetable food, though some add fish, and others birds and worms.‖ The pecora use herbs and grasses. So the bellua;¶ though the swine tribe will eat any thing.** The cetaceous fishes seek the insects and produce of the ocean. But the power which some quadrupeds show of living without food would lead us to inquire, if in a state of nature the appetites of many are not more moderate in their general desires, with stronger urgency in particular seasons.††

* The jacchus, or striate monkey, takes insects and small birds; and the taillese macauco, eggs and small birds.—Turt. Linn. p. 20, 21....The monists of Morocco searched for spiders, ants, and other insects, in addition to its bread and fruits.—Kerr's Linn. 71.

† As the ant-eaters; the armadilloes.

‡ We may infer the quantity they consume, and therefore the amount of vegetation necessary to be produced for their sustenance, by the following account of the nutrition of a cow: "A cow consumes on an average 100lbs. of green food in 24 hours. This, for 185 days of summer, is 18,500lbs. In winter, 45lbs. of root a day, or, for 180 days, 8,100lbs. One-third of this may be potatoes, the rest other roots. But she gives, if well fed, 2,000 quarts of milk a year."—Allen's Hints for Schools of Industry.

§ But some of this genus also eat vegetables; as the dog, which feeds on farinaceous vegetables, but not greens, as well as on flesh. So the jackals eat fruit as well as birds and lesser animals.—T. L. 44....The fox fattens on grapes.—P. 45....The Brasilian weasel and the civet feed on apples and bread, as well as on mice and worms.—P. 52, 54....The martin takes ripe fruit, besides birds and frogs.—P. 59....The bear seeks roots, berries, and other vegetables, as well as insects, honey, and carcasses.—P. 62....The badger, opossum, and hedgehog use both kinds.—P. 63, 65, 73.

‖ The river cavy, cassybara, feeds on fish, which it catches at night, and vegetables.—T. L. 77....The Chilese beaver on crabs.—178....The musk-rat on shell-fish, as well as fruits and herbs in summer, and the roots of flags and water-lilies in winter.—79....The Norway rat takes poultry, and the field mouse small birds.—80, 81....The water rat eats frogs, insects, and small fish, as well as roots and bark.—83....The Madagascar squirrel draws worms out of trees.—94.

¶ The common hog eats serpents without injury, and will even devour its own offspring.—T. Linn. 125....The Mexican hog feeds on reptiles, as well as on fruit and roots.—126.

** The striped hyena, though it will tear up bodies from burying-grounds, yet "lives long without food."—T. Linn. 44....The sloth, bradypus, "can live a prodigious time without food; Kercher says 40 days."—Kerr's Linnæus, p. 101....The bear fasts from the middle of November to the end of winter.—185....In the bird order, Wilson states

The pursuit, in animals of prey, and the supply are so adjusted to each other, that the general harmony, course, and happiness of creation are never disturbed. Such is the fitted balance, that the husbandman frquently injures himself by destroying those which, on a partial view he thinks injurious to him.* The consuming animals, the degree of their consumption, and the species consumed are so precisely adapted to each other, that neither deficiency nor exuberance appear while the appointed operations of natur are unimpeded. Man, by interfering, may alter the provided equilibrium; and when he does so, he suffers from his injudicious interposition, or too covetous anxiety.

That animals have organs of sense corresponding with those of man, we all familiarly know. They see, hear, taste, smell, and feel, as well as we do, and some much more acutely. Both the dog and the wolf have an exquisite sense of smell.† The cat, and some others, can see in the dark. The lynx is acute both in sight and smell.‡ The racoon is peculiarly sensitive in both smell and touch.§ Others have a quickness of hearing superior to ourselves ;‖

of the whitebreasted hawk, "one lived with me *several weeks*, but refused to eat. Though he lived so long without food, he was found, on dissection, to be exceedingly fat." Amer. Ornith. vol. i. p. 85.... Those animals which live on particular roots, herbs, or insects, can have this food only in the season while these things are existing.

* Thus farmers destroy moles, because the hillocks they make break the level surface; but they have found worms so much increase when the moles were gone, as to wish they had not molested them. Moles live on worms, insects, snails, frogs, and larva. The farmers on a nobleman's estate in France found the moles' disturbance of the earth such a good husbandry to it, as to solicit their landlord not to have them killed.—Bull. Un. 1829. p. 334....So toads are found to keep down the ants. Mice have increased in barns where owls have been shot. The blue jay was destroyed in America for eating the peas; but the pea grub, which it fed on, became more destructive afterward. A gentleman shot a magpie, to save his cherries, but found its craw as full as it could be crammed with the large blue-bottle flies that lay their eggs in meat. "The fox renders considerable service to man, by the quantity of rats, field-mice, frogs, toads, lizards, and snakes which he destroys." —Howit's Brit. Preserv.

† T. Linnæus, 43.

‡ T. Linn. 51.—No beast can discover its prey at so great a distance. The marmot has also "a quick eye, and discovers an enemy at a considerable distance."—Bingl. ii. p. 33.

§ *Ib.* 64.

‖ Cuvier remarks of the mole, that though its sight is weak, its hearing is remarkably fine; its touch delicate, and its sense of smelling most exquisite. Cuv. An. Kingd.....The senses of taste and smell are

and some appear to be impressible by musical sounds.* In the evolution of the animal embryo, the formation of its nervous system appears to precede its circulatory functions and fluid.† And some too curious experiments, painful to read of, and therefore not laudable to repeat, seem to ascertain that the principle of life is independent of the nervous matter, as it continues in the body for some time after the brain and spinal marrow are removed.‡

All the quadrupeds utter sounds of some sort or other,

very active in the hog; and in the African species the smelling and hearing are remarkably acute.—B. 149, 153....The bison's faculty of smell is so perceptive, that they scent their enemy at a great distance, and precipitately retire as he approaches....The rhinoceros is remarkably acute in its hearing and smell.—Kerr's Linn. 113....The blind mole-rat, typhlus, is very quick in its senses of hearing, touch, and smell.—T. —Linn. 88....The common hare has exquisite hearing and sight.—100 ....The cape hyrax has acute ears.—103....The chamois excels in sight and smell.—111....So does the Scythian antelope.—112....The wild mule has acute hearing and smell.—122....The red deer and wild asses are equally gifted.—2 B. 82, 131.

* The wolf dreads the sound of a trumpet.—Kerr's Linn. 43....The hare is fond of the sound of a drum.—106....The lamantin manati delights in music —119....Two elephants at Paris were found to be excited by bold and wild music, and soothed by a soft air on the bassoon. —B. 1, p. 146....Suetonius mentions that Domitian had a troop of elephants disciplined to dance to music. The dog howls at certain notes of music.—Kerr's Linn. p. 130....The hippopotamus is affected by it. "As we passed along the borders of the lake at sunrise, the hippopotamus *followed* the drums of the different chiefs the whole length of the water; sometimes approaching close to the shore. I counted fifteen at once, sporting on the surface."—Finlayson's Siam.

† M. Baumgarten's investigations were, that the spinal marrow and the brain may be perceived before the blood is seen. These parts are not formed by the blood; but have acquired some perfection before that exists. The formation of the blood is made under the influence of the nervous system. Hence the nervous system contributes to the formation of the first blood.—Feruss. Bull. Univ.—1830, p. 196.

‡ M Weinhold cut off a cat's head; and when its arterial pulsation and muscular movements had ceased, took out its spinal marrow, and filled up its canal with an amalgam of mercury, silver, and zinc. Immediately the pulsation recommenced, and the animal made a variety of movements. In another cat he removed the brain and spinal marrow, and filled the scull and vertebral canal with the same metallic mixture. Life appeared to be instantaneously restored. The animal lifted up its head; opened and shut its eyes; looked with a fixed stare; endeavoured to walk; and whenever it fell, raised itself again on its paws. It continued in this state for twenty minutes, when it fell down, and remained motionless. During all this time the circulation of the blood appeared to go on regularly; the secretion of the gastric juice was more than usual; and the animal heat was re-established. Florence Anthology, quoted in Court Journal, 10th Oct. 1829.

which they can vary into so many tones as are necessary to give vent to their feelings, to denote their wants, or to communicate with each other. Whoever attends to their poultry-yard, will soon perceive that each species uses particular modifications of sound, to signify to their brood and fellows what they wish them to understand, and each seems perfectly to comprehend the meaning of the speaker.* Many animals have been remarked for their communications, by utterance to each other.† The sloth, in the modifications of its plaintive cry, ascends and descends regularly through six musical notes.‡ One monkey has been noticed to utter vocal syllables ;§ and dogs have been taught to ex-

* At their accustomed hour of being fed, if it be delayed, all are clamorous for it. The cock repeatedly calls his hens to it, if they be absent; and these their chickens. The maternal notes, to express danger to her brood; those of anger against an assailant; of alarm at their own peril; and their calls for each other, when those accustomed to be together are separated and unseen, are very distinguishable. All these are appropriated to their respective sensations, and are only repeated as these occur. Ray has remarked the different voices of the hen, when she broods; when she leads her chickens; when she has found food, and calls them to it; when she would alarm them to seek shelter; when she is angry; when she has laid an egg; when in pain, or great fear—"all significant—being effects of the several passions of anger, grief, fear, or joy."—Ray. Wisd. 160 ... Gilbert White, in his Selborne, makes some just remarks on the language of birds.—S. 43, p. 277.

† "The chamois, when alarmed, advertise each other of their feelings by a kind of whistle The one on watch continues this as long as he can blow without taking breath. He then stops for a moment, looks round on all sides, and begins whistling afresh, which he continues from time to time. He leaps on the highest stones he can find, again looks round, leaps from one place to another, and when he discovers any thing seriously alarming, flies off."—Bingley, vol. ii. p. 93.... Many of the ape species, when beaten, will sigh, groan, and weep like children. A pigmy ape, when left alone, used to make a doleful cry.—*Ib.* i. p. 71.... The four-fingered monkey, when touched, utters a plaintive kind of cry; but has another sound, which it emits as a testification of delight at receiving any kind of food.—*Ib.* 87 ... When female seals come ont of the sea, they bleat like sheep for their young.—*Ib.* 161.

‡ "The voice is an ascending hexachord, or six successively rising notes."—T. Linn. 101.... "Sloths are most active at night. Then they utter a plaintive cry, ascending and descending in perfect time through six successive musical intervals. When the Spaniards first heard this, they thought they were near some nation who had been instructed in European music."—Bingl. i. p. 113.

§ The fearful monkey, simia trepida. They frequently whistle; and, when enraged, shake their heads violently, and utter, in a ferocious tone, the syllables pi, ca, rou —Bingl. i. p. 89; Buffon, viii. p. 193; and Pennant Quad. 116, describe him.

express human words,* even so large a number as thirty, distinctly intelligible.† The monkey tribe give strong indications of mutual communication and comprehension by their vocal utterance.‡

It is one of the great distinctions of the animal mind, and of its similarity, within its prescribed scale and compass, to our own, that it is both teachable to several intelligent actions, and also susceptive of moral docility. Thus far it is improvable, but not beyond. By this limitation, it is divided from the human soul, of which an indefinite and unceasing improvability is its universal property, though the largest part of mankind but little avail themselves of it. But that degree of moral ductility and capacity of education which taming exhibits seems to be a general quality of the animal mind, as the fiercest have been subjected to it. Of the feræ genera, which includes all the wild and ferocious, the largest have been found tameable.§ Even the tiger, who may be considered as the

* The Dumfries Journal, in Jan. 1829, mentioned a dog as then living in that city, which uttered distinctly the word "William;" the name of the young man to whom it was much attached.

† It is Leibnitz who has transmitted this fact to posterity; on which the French academicians reasonably say, that if it had not been testified by so great a man, they should have doubted it. He communicated it to the Royal Academy at Paris, who published his letter in their history. It was a peasant's dog, whose son taught it, when three years old, to articulate distinctly thirty common words. Leibnitz declares that he heard it utter them.

‡ When they go in companies to a field of rice or sugar-canes, one stands sentinel on a tree, while the rest plunder. If the owners appear, he cries out, Houp! houp! houp! which the rest immediately understand, and throwing down the corn in the left hand, and retaining only what is in the right, scamper off on three legs as fast as they can.—Goldsm. N. H. vol. ii. p. 480.... Marcgrave's account of the Ouarine monkey presents a curious picture: "*I have frequently been a witness* of their assemblies and deliberations. Every day they assemble in the woods to receive instructions. One then takes the highest place on a tree, and makes a signal with his hand for the rest to sit around. As soon as he sees them placed he begins his discourse in a loud and precipitate voice: the rest observe a profound silence. When he has done, he makes a sign with his hand for the rest to reply. At that instant they raise their voices together, until by another signal they are enjoined silence. At last the assembly breaks up."

§ The jackal, when taken young, acquires the same affectionate manners as a dog.—K. Linn. 140.... The lion has been repeatedly tamed. So has the fox. Rubens had a tame lion four weeks in his chamber, to paint from. Pennant saw an hyena as tame as a dog. The large babyroussa, "though brutal and ferocious, are easily tamed."—Buffon.

fiercest of the fierce, has exhibited this improvability.* So has the savage and voracious hyena.† Crocodiles have been made harmless and docile.‡ The leopard likewise.§ The wolf has also shown that it possesses what we may term affectionate docilities.‖ The baboons become vigilant guardians of their protectors' property.¶ These facts prove

....The ounce may be trained to hunt, and become as tractable as a pointer.—K. Linn. 148....The large tiger-cat is easily tamed.—152.... The mountain lynx has mild and gentle manners.—155....The Egyptian ichneumon may be softened so as to be kept in a house, like a cat. —159....The otter may be taught to catch fish for its master.—173.... The ferret is domesticated, and employed to catch rabbits.—180....The snow-weasel may be trained to follow a person anywhere.—183....We see the bear repeatedly in our public streets. The badger may be also made docile, if caught young.—187. The racoon is easily tamed, and sportive, but unlucky and inquisitive, like a monkey.—189....The rhinoceros may be tamed in some degree.—113....The hippotamus also. —P. 347.

* The tiger, if taken young, may be domesticated. One, six weeks old, was taken on board the Pitt East Indiaman, in 1790, and arrived in England before it had quite completed its first year. It was as playful as a kitten, and frequently slept with the sailors in their hammocks. It would run out on the bowsprit, climb about the ship like a cat, and play with a dog there. Deposited in the Tower of London, it continued there to be perfectly good-natured, and was never guilty of any savage tricks. In 1801, it admitted a puppy terrier and mastiff to be successively its inmates, and recognised with delight the ship-carpenter, who came to see him two years after they had been separated, licked his hands, and fawned upon him like a cat.—Bingl. An. Biog. v. i. p. 230. The faquirs of Hindostan sometimes go about with their tame tigers.

† Bishop Heber mentions that Mr. Trail, in India, had an hyena for several years which followed him like a dog, and fawned on his acquaintance.

‡ A tame crocodile was, in 1828, kept at Chantilly. It was so mild, that it was caressed by its keeper without danger.

§ Mrs. Bowditch, widow of the Ashantee traveller, had a tame leopard. Gesner mentions that Francis I. kept one, which he used in hunting. It was carried before him by an attendant on a horse. Mr. Barrow procured, in Africa, a young leopard, which "became instantly tame, and as playful as the kitten."

‖ M. F. Cuvier describes a young wolf that was brought up like a young dog. It became familiar with every person whom he was in the habit of seeing, followed his master everywhere, was obedient to his voice, and differed in nothing from the tamest dog. Its owner gave him to the Royal Menagerie at Paris; and was affectionately recognised by it eighteen months afterward. When, after another absence of three years, he went to it, though it was dark, it knew him by his voice, placed its forepaws on his shoulders and licked his face, and became ill and pined because he went away.

¶ Kolben mentions of the baboons at the Cape, that if brought up young with milk, they become as watchful over their master's things

that there is nothing in the nature of the wildest animals to make their future gentleness and sociability either impossible or improbable. We see by the dog and cat that the carnivorous may be mild and friendly; as we find those which feed on grass and herbs may be wild.* Even now the devourers and their prey may, by kind and judicious management, be trained to live peaceably and harmlessly together.† Nothing appears more effectual to produce this pleasing melioration than patient and persevering kind and gentle treatment.‡ They are now wild and savage,

as any house dog.... Vaillant declares of the one he had, that it was more watchful than any of his dogs, and frequently warned him of the approach of predatory animals, when the dogs seemed unconscious that they were near.... Father Carli, in his History of Angola, mentions that he had taught monkeys to attend him, to guard him, while sleeping, against thieves and rats, to comb his head and fetch his water.—Goldsm. N. H. vol. ii. p. 493.

* The bison and buffalo, though graminivorous, are fierce and dangerous; and Mr. Cunningham, in his account of New South Wales, remarks, "Our *wild* animals are numerous, but few of them are carnivorous." The form of the teeth is not decisive of their nature in this respect, for "though the tapir's mouth is armed with twenty sharp cutting teeth, he is not carnivorous."—Buffon.

† In 1827, M. Pelletan, director of the African Company at Senegal, trained a lion, caught in the forest there, to be very tractable, and to live in amity with the other animals which his master kept. He slept in the same place with sheep, dogs, cats, monkeys, geese, and ducks. When eight months old, a terrier brought forth two puppies on his bed, which excited a great interest in him, and he caressed them as if their parent.—Bingl. An. Biog. vol. i. p. 222.... At New Hargard, in Germany, the landlord placed on the floor a large dish of soup, and then gave a loud whistle; immediately a mastiff, an Angora cat, an old raven, and a large rat with a bell, entered the room. All four went to the dish and fed together.—*Ib.* vol. ii. p. 21.... John Austin, who for seventeen years had occupied himself in "training creatures of opposite natures to live together in content and affection," exhibited, in his ambulatory show, a cat, a rat, a mouse, a hawk, a rabbit, a Guinea-pig, an owl, a pigeon, a starling, and a sparrow, all living harmoniously together in a cage of such dimensions as he could carry about. He effected this amity by keeping them all well fed, and by accustoming each to the other at a very early period of their lives.—Menageries. vol. i. Lib. Entert. Knowl.

‡ In educating the ox for the plough, Mr. Cobbett very sensibly recommends that "all violence and rough language should be avoided." "If he be stubborn, there should be no blows and no loud scolding. Stop; pat him; pat the other ox; and he will presently move on again. If he lie down, let him lie till he is tired; and when he chooses to get up, treat him very gently, as if he had been doing every thing that was right. By these means a young ox will in a few days be broken to his labour. With gentle treatment, he is always of the same temper; always of the same aptitude to labour."... Is not this judicious advice applicable also to much higher beings than oxen? On the same prin-

from the appointed circumstances amid which they are at present ordained to live; and when this state of the general world shall be altered, their moral transformation will become a natural appendage to the great social and intellectual revolution which the Hebrew prophets attach to the ulterior ages.* It is in animals as in fish—the largest are the mildest. The vast hippopotamus, the rhinoceros, and the elephant are as gentle and harmless as the sturgeon and the whale.†

That animals have feelings and passions very analogous to our own appears from many instances. Our rugged or oppressive conduct towards them more usually puts their resentful emotions into action, than their better capabilities; and this has caused their angry humours to be most frequently noticed.‡ But many species show what must be

ciple, an experienced cavalry officer once told me that he did not fear the most vicious horse, and would soon cure it. I asked him as to his means; his answer was, "Always by mild and gentle treatment and forbearing patience. If you whip them, you make them bad tempered and continuedly vicious; but steady kindness, occasional humouring, as far as was safe, with a hard run now and then, to let their spirit exhaust itself, constituted always the most successful system."

* Isaiah twice mentions this future condition of the earth, ch. xi. 6–9, and ch. lxv. 25; and Hosea, ch. ii. 18, alludes to it.

† A power of subduing the mind or spirit of animals seems to be attainable by human ingenuity, though self-interest may conceal the practical means. The Rev. H. Townsend mentions a man in Ireland who would make any horse, however vicious or unruly, become, in half an hour, gentle and tractable, and durably so. When sent for, he ordered the stable door to be shut, and not to be opened until he gave the signal. After being alone with the horse for half an hour, during which little or no bustle was heard, he ordered the door to be unclosed. The refractory horse then appeared lying down, and the man by his side, playing with him familiarly as a child with a puppy. Mr. T. tried him with a trooper's horse that would not stand to be shod. He completely succeeded. "I observed that the animal appeared terrified whenever Sullivan either spoke or looked at him."—Rev. H. Townsend's Statistical Survey of Cork.

‡ A rackoon, having been one day lashed by a servant, would never forgive him. Neither eggs nor fish, of which he was very fond, would appease it. Whenever the man approached, its eyes kindled; it endeavoured to spring at him; uttered mournful cries, and refused every thing offered until the servant went away.—Bingl. An. Biog. vol. i. p. 290.....The patient camel retains the remembrance of an injury until he can avenge it; but is satisfied if it can believe that it has done so. When an Arab has excited his resentment, he disposes his clothes on a place which the animal will pass, so as to resemble himself sleeping under them. The camel recognises the garments, seizes them with his teeth, shakes them with violence, and tramples on them. After it has

called kind affections. Monkeys evince them to each other.* Cows will protect each other,† and feel strongly for their young.‡ Most animals evince pleasure at being caressed.§ Bears have exhibited strongly both connubial

taken this satisfaction, the owner may reappear, load, and guide him as he pleases.—*Ib.* vol. ii. p. 61.... The elephant's retaining his resentment, and unexpectedly revenging himself, have been frequently noticed.

* The male and female are never tired of fondling their young one. Golds. vol. ii. p. 591.....Captain Crowe had several monkeys in his ship, of which one became sick. "It had been always a favourite with the others; and from the moment it was taken ill, they tended and nursed it with anxiety and tenderness. A struggle frequently ensued among them for priority in these offices of affection. Some would steal one thing, others another, in order to carry it to it, untasted by themselves, however tempting. They would take it up gently in their forepaws, hug it to their breasts, and cry over it, as a mother would over a suffering child. The little creature seemed sensible of their assiduities. It would sometimes come to me, and look me pitifully in the face, and cry, as if asking me to give it relief."—Crowe's Memoirs, 1830....Of two chimpanzees, from the Carnatic, the female died on the voyage. The male showed every sign of grief, refused to eat, and expired two days afterward.—Bingl. vol. i. p. 55....Buffon, in 1764, had two fearful monkeys. When their young one came, he says nothing could be more beautiful than to see the two parents occupied with it. They were always carrying about or caressing it. The male loved it greatly. They held it alternately; but now and then, when it did not hold properly, they gave it a severe bite.

† I saw a dog in Petersham meadows barking at a cow. The other cows about turned round at his noise, and perceiving him, walked slowly up to the other, as if to assist her. The next month this occurred more decidedly there; a dog attacked one of the cows, which bent her head to present her horns. He persisted, and she, intimidated, retreated, while he pursued her. The other cows at a distance first raised their heads to listen; then turned round to the sound, and, seeing their fellow-cow still distressed by the dog, one moved towards her; then two others; another furiously galloped up to them, and six formed into a semicircle round her to protect her. The dog, undismayed, renewed his attack, when one of the assisting cows left the circle and ran deliberately at him. The dog quitted the one whom he was persecuting; but seeing the other continuing to rush at him, seemed to think that he was in danger, and moved away silently and slowly. But the excited cow went after him. He then quickened his walk into a run. She galloped determinately after him as fast as she could, as if to punish him, till he at last outran her and escaped.

‡ In September, 1829, the Cheltenham Chronicle described a cow, in the week preceding had run hastily up to a gentleman's bailiff that had entered the field. Mistaking her intentions, he moved away. She then stopped and bellowed in a distressing manner, as if to gain his attention. Seeing him look towards her, she went to a ditch, and again made a loud noise. He walked to it, and saw a calf on its back, almost lifeless from its ineffectual struggles to release itself. He pulled it out just in time to save its life, when the mother jumped and fondled round him like a dog, frequently licking his hand.

§ I have tried this with cows and sheep. Many others, especially

and maternal sensibilities.* The beaver has felt or imitated them.† Lions‡ also discover the same sympathies to be

horses and elephants, as well as our domesticated ones, manifest their gratification at being kindly noticed. Sir W. Jones mentions of the slow lemur which he kept, "At all times he was pleased with being stroked on the head and throat. If I presented my finger to him, he licked or nibbled it with great gentleness."—Asiat. Reg. vol iv. . . . Jackals love to be fondled and patted with the hand; and when called, will leap on a chair.—Pennant, Quad. . . . .The Brazilian paca licks the hand that caresses it; and if gently stroked on its back, by a small cry expresses its acknowledgments, and seems to solicit a continuance of the favour. Buffon had the one he describes.

* Mr. Hearne describes the males of this species as so much attached to their mates at some times of the year, that he has often seen one of them advance when a female was killed, and put his paws over her, and in this position suffer himself to be shot rather than quit her. —Hearne's Jour..... "The female bear seems to love her young with astonishing ardour. She prepares for them a bed of moss and herbs at the bottom of her cavern, and suckles them till able to go abroad with her."—Buffon.

When the Carcasse frigate was locked in the northern ice, a she-bear and her two cubs, nearly as large as herself, came towards them. The crew threw to them great lumps of sea-horse blubber. The old bear fetched these away singly, and divided them between her young ones, reserving but a small piece for herself. The sailors shot the cubs as she was conveying the last portion, and wounded her. She could just crawl with it to them, tore it in pieces, and laid it before them. When she saw they did not eat, she laid her paws first on one, then on the other, and tried to raise them up, moaning pitifully all the while. She then moved from them, looked back, and moaned, as if for them to follow her. Finding they did not, she returned, smelt them, and licked their wounds; again left them, again returned; and with signs of inexpressible fondness went round them, pawing and moaning. At last she raised her head towards the ship, and uttered a growl of despair, when a volley of musket balls killed her.—Phipp's Voyage. Bingley, vol. i. p. 283.

† Where a tame beaver was kept, a cat with kittens took possession of its bed. It did not turn her out; but when she chose to be absent, it often took one of the kittens in its paws, and held it to his breast to warm it, and seemed to dote upon it. As soon as the cat came back, the beaver always restored the kitten to her.—Bingl. An. Biog. vol. ii. p. 15. . . . . The beavers are also playful. Near the arctic regions, "a gentleman espied five young beavers sporting in the water; leaping upon the trunk of a tree, pushing one another off, and playing a thousand fantastic tricks." He was about to fire on them, but saw "such a similitude between their gestures and the infantile caresses of his own children, that he threw away his gun."—Capt. Frankl. Journ. p. 92.

‡ Mr. Hope relates, that dining one day with the Duchess of Hamilton, who kept a lion, a sergeant with recruits arrived at the gate, and begged to see it. Being admitted, the sergeant, who three years before had taken care of him from Gibraltar, called him by his name, "Nero;" and the animal rose up from his food, and came wagging his tail to the side of

within them. So have the unmanageable elks.* The apes and orang outangs have repeatedly indicated affectionate sympathies.† Even the hog we despise is not destitute of them; and is peculiarly sensitive of weather, and naturally select in its food.‡ But all classes of animals, from the

the cage, where the man patted him. He seemed pleased; went to and fro, rubbing himself against the place where his benefactor stood, and licking his hand as it was held out to him.—Bingl. An. Biog. vol. i. p. 219..... A negro, who had reared a lion and lioness from whelps, came with them from Africa to the late Exeter 'Change in London. They permitted him to enter their den, and would fawn and play round him like kittens. He frequently had a table in their den, and sitting down there, would quietly smoke his pipe.—*Ib.* 220.... Sir George Davis had brought up a lion from a whelp; and at five years old parted with it, as it began to be mischievous. Three years afterward, he saw it in the grand-duke's menagerie at Florence. Though then fierce to others, when Sir George appeared at the gate the animal remembered him, ran to him, reared up, and licked his hand. He entered its den, and the lion threw its paws upon his shoulders, licked his face, and ran about the place, fawning and as full of joy as a dog at the sight of his master.—*Ib.* 218.

* M. D'Obsonville, in the East Indies, kept an elk, from twelve days old, for two years. It always came when he called. Leaving Sumatra, he gave it to Mr. Law; in whose country house, being chained and alone, it became furious and dangerous. Some months afterward D'Obsonville returned and went to it. "It knew me afar off. I ran to meet it, and shall never forget the impressions of its transports and caresses."—Bingl. vol. ii. p. 73.... Dr. W. Hunter's nylghau always licked the hand that stroked it or gave it bread.... Darell had an elk caught young, which was singularly docile and sagacious, and lived many years domesticated with him.—Swed. Ac. Sciences.

† An orang outang, brought in 1817 from Borneo, and described by Mr. Abel, soon became attached to those persons who used him kindly; would sit by their side, and run to them for protection.... The female one brought to Holland in 1776 loved to be with those to whose care she was intrusted. "Her keeper having sometimes sat near her on the ground, she would frequently take the hay of her bed, arrange it by her side, and with the greatest anxiety and affection invite him to sit down."—Bingl. vol. i. p. 58.

‡ "It appears to foresee the approach of bad weather; bringing straw in its mouth to its sty, preparing a bed, and hiding itself from the impending storm. Nor is it less agitated when it hears any of its kind in distress. When a hog is caught in a gate, or suffers from any domestic operations, all the rest are seen to gather round it, to lend their fruitless assistance, and to sympathize with its sufferings."—Goldsm. vol. ii. p. 168....In their natural or wild state, they are the most delicate in the choice of what vegetables they shall feed on; and reject a greater number than most of the rest. Linnæus states the cow to eat 276 plants, and refuse 218; the goat eats 449, and declines 126; the sheep takes 387, and rejects 141; the horse likes 202, and avoids 212. "But the hog, more nice in its provision than any of the former, eats but 73 plants, and rejects 171."—Goldsm. p. 166.

greatest to the least, have given striking demonstrations that their mental principle has these moral sensitivities as truly as the superior human spirit.*

LETTER XIV.

A brief Review of the Qualities, Phenomena and Character of the Quadruped Mind

FROM the senses and sensibilities of quadrupeds let us pass to the consideration of their indications of a perceiving, attending, and thinking mind.

To collect provisions for their future use, to hoard them in safe places, and to use them gradually for their daily sustenance, are actions in the human race which display and require great prudence, foresight, just reasoning, will acting upon judgment, and much self-command. A very

* "The sea-otters are so affectionate to their young, that they will pine to death at the loss of them; and die on the very spot where those have been taken from them. They are very sportive, embrace each other, and even kiss."—Pennant.... If the hunters come on the female by surprise, and separate her from her young one, the cub is instantly taken; but the mother no sooner hears its cries than she swims to the boat from which they proceed; and, regardless of all danger, shares its fate.

Buffon remarks of the mole—"So lively and reciprocal an attachment subsists between the male and female, that they seem to dread or disrelish all other society. They enjoy the placid habits of repose and of solitude." He describes the curious architecture of their subterraneous abode and its passages.

In 1827, at Brighton, an hyena was shown, with its usual fierceness; but the young man coming in who some years before had reared it from a cub, and brought it to England, though it was snarling and snapping at others as he entered, yet it recognised him, bounded about the cage in manifest delight, rubbed himself against the young man's hand that patted his head, and seemed gratified by his caresses.

Monkeys abound at Gibraltar. In a letter from thence, in 1827, the writer says, "I fell in with a family of ten, and watched their motions. They appeared to be a father and mother, with five grown up, and three small ones. Of these, one was still at the breast, though large enough to be weaned. The mother was sitting with great gravity, nursing it with her hand behind it. The older offspring were skipping up and down the rocks and walls, playing all sorts of antic tricks with one another."

large portion of mankind will not exert either this forethought, or the self-government that alone makes it effectual. The Scottish nation is eminently and honourably distinguished for this intellectual quality and power. The lower Irish are too often conspicuous for the want of it. Yet this is strikingly exhibited in the alpine hares, who literally make hay for their winter food;* in the active and provident squirrels;† in the ingenious beaver;‡ and by many of the glires genus.§

* Pennant describes this habit in the alpine hares of Siberia. In August they begin to cut great quantities of soft, tender grass and other herbs, which they spread out to dry. This hay, about autumn, they collect into large heaps, and place either beneath the overhanging rocks, or between the chasms, or round the trunks of trees, in conical heaps of various sizes, according to the number of the society that makes them. They are usually about three feet high. Being covered in winter by snow, the animals form a trodden path from their holes to them. "They select the best of vegetables, and crop them when in the fullest vigour, which they make into the best and greenest hay, by the judicious manner in which they dry it. These ricks are the origin of fertility among the rocks; for the relics, mixed with the animals' soil, rot in the barren chasms, and create a soil productive of vegetables."—Penn. A. Zool.

† The common squirrel makes a nest of moss and dried leaves at the forks of a tree's branches, with two holes at opposite sides, and as the wind varies shuts the hole towards it. It lays up magazines of nuts, acorns, fruit, and berries for winter.—Kerr, Linn. p. 256. It places these in the hollows of the tree, never touching them till wanted. The larger American squirrel puts its store under ground.—258. The ground species in Canada never willingly ascends trees, but makes its burrows under the earth, with long branched galleries leading to several apartments, in which it deposites maize, acorns, nuts, and chestnuts, all in separate chambers, for its winter food.—Pennant.

‡ The beavers build their houses together, like small villages. Each cabin has in its neighbourhood a magazine of bark and boughs of trees for winter provision, kept constantly under water.—K. Linn. 223.

§ Thus the field-mouse collects large stores of grain, nuts, acorns, and beech-mast, in its places under ground. The hogs, by their exquisite smell, are often led to their hoards, and dig them up.—K. Linn. 230. The Siberian mouse makes similar collections of garlic roots, which it is fond of.—236. The economic-mouse in Kamschatka forms magazines of bulbous-roots under the turf, which it lays out to dry on sunny days, and never touches but in winter.—238. The German hamster makes large chambers for grain, beans, pease, and linseed, each in a separate cell, sometimes a hundred pounds weight in the whole.—243. The dormouse and brown-rat have the same habit.—220. The jerboa also collects the purest herbs in her subterraneous burrows. The Casan marmot likewise.—252. The zemni, or Podolian one, which pervades Asia, also. "Each individual has its separate burrow, in which, for provision in the beginning and end of winter (for in the middle it lies torpid), it lays up magazines of grain, tender vegetables, and berries; sometimes adding mice and small birds."—K. Linn. 253.

The tuition which quadrupeds are capable of receiving discovers a lower degree of that improvability which distinguishes our superior race, which, as far as it extends, resembles ours, although at the same time it marks its specific difference by its unvarying limitation. Apes have often amused their possessors by their imitative faculty.* Cats display this teachability.† Pigs have also repeatedly shown that they can learn to do things not natural to them.‡ A sow has been trained to the services of a pointer.§

* Blumenbach's ape, which he kept above a year, would manage the wood for his stove, and put it in with as much judgment and economy as a cookmaid. He was often at the college, and used to examine the pupils' specimens with amusing imitation and grimace. One day he found a work on insects on the table, which he studied with great gravity; but a person entering the room an hour afterward, found that the ape had with great dexterity pinched out all the beetles of the large plates, and eaten them, mistaking the pictures for real insects. This was an unlucky, but not a foolish action.

Vosmaer's orang outang was taught to eat with a spoon and fork, and picked out his strawberries one by one from a plate. Getting loose one day, it uncorked a bottle of Malaga wine, drank it off, and put the bottle in its place. Seeing others open its chain-padlock with a key, it put a bit of stick into the key-hole, and turned it about in all directions to unlock it itself.... Buffon describes one that he had seen sit down at table, unfold his towel, wipe his lips, use his fork, pour liquor into a glass, and make it touch that of the person who drank with him. At tea it brought a cup and saucer, placed them on the table, put in sugar, and poured out the tea. But in the woods this animal sits by the fire the negroes leave till it burns out, without adding to it fresh fuel.... Dampier mentions the striated monkeys to take up oysters from the beach, place them on a stone, and beat them with another till they got at the fish..... Gamelli Careri describes others to watch the oysters that open, and then to put a stone within them to hinder them closing on their paws as they pull them out.

† In 1828 a cat from Tuscany was exhibited in London that had been trained to beat a drum, strike on an anvil, draw water from a well, ring bells, and roast coffee.

‡ I saw a large pig at Ross which could pick out from an alphabet on the ground, on being ordered, and without mistake, the letters that were wanted for the name of any persons present; and also the figures for the hour. The watch was placed to its eye, but the secret-directing signs must have been previously established between it and its master. It went round the dial, and placed its snout first on the hour, and then in another circuit on the minutes. There was no visible concert that I could trace, so that the assisting tokens were the more intellectual. The owner mentioned, that being more dull at learning than some, it had taken him three months' close labour to teach him.

§ A black sow was taught to find game, and to back and stand nearly as well as a pointer. When very young she became attached to some pointer puppies, and the keeper resolved to try her. He gave her some

The quadruped animals, of their own will and nature, and from inborn instincts, do actions which require knowledge, reasoning, and judgment in mankind. Reindeers follow and obey leaders of their own species.* Elephants also make their journeys on this plan, when they deem it necessary.† Baboons have been found to make defensive arrangements, like military tactics.‡ Mules and cats make signals to have a door opened.§ Bisons place themselves in the best position for repelling an enemy.‖ The black bear's mode of fishing is as dexterous as any schoolboy's

pudding of barley-meal as her reward, and threw stones at her when she did wrong. By this mode he soon taught her what he wished. As soon as the game she pointed rose, she always returned to him for her reward.—Bing. An. Biog. vol. ii. p. 148.

* Mr. Bullock brought a herd of twelve reindeer from Norway. They seemed to be completely under the command of a leader or captain, who not only headed their march, but appeared on every difficulty to give orders that were obeyed....The Mongolian antelopes run in a regular file, led by an old one.—K. Linn. 311.

† The elephants are seldom seen alone. They generally move in bodies. In dangerous marches the oldest are the foremost, the young and feeble in the middle, and the next in age bring up the rear.—Bingl. p. 130....The Hottentots told Mr. Pringle that in the dense thorny forests the great bull elephants always march in the van, bursting through the jungle, treading down the thorny brushwood, and breaking off with their trunks the larger branches that obstruct the passage, while the females and younger part follow them in single file.—Menag. vol. vii. p. 36.

‡ A Cape baboon having taken off some clothes from the barracks Lieut. Shipp formed a party to recover them. "With twenty men, I made a circuit to cut them off from the caverns to which they always fled for shelter. They observed my movements, and detaching about fifty to guard the entrance, the others kept their post. We could see them collecting large stones and other missiles. One old gray-headed one, who had often paid us a visit at our barracks, was seen distributing his orders as if a general. We rushed on to the attack, when, on a scream from him, they rolled down enormous stones upon us, so that we were forced to give up the contest."—Shipp's Memoirs, vol. i. p. 86.

§ As our cat, when she wanted to be let into the room, always rose up and shook the handle of the door outside till she was admitted, which she had taught herself to do from seeing that we opened it by that to let ourselves out and in, I can believe the account in a Dublin paper, that a mule which had strayed was found the next day at the gate, pulling the knob of the bell-handle violently till he was let in. On the three preceding days he had seen his driver in the market-cart ring it for admission.

‖ "When bisons scent the approach of a drove of wolves, the herd throw themselves into the form of a circle, placing the weakest in the middle and the strongest outside, and thus present an impenetrable forest of horns."—Bingley, vol. ii. p. 116.

could be, but more patient than he would be.* Even the selfish depredation of the monkey, too craving of others' food to be sufficiently careful of his own, was an intellectual action.† All these display what many human beings would do in the same circumstances, and for the same ends.

Deliberating, judging, and persevering mind, with real building skill, appears as much in the beaver's construction of his cabin as in any human fabrication of a cottage.‡ The curiosity of a petted weasel resembled the same quality in its mistress.§ If it be foreseeing caution in a military officer to place sentinels to watch and give alarm on danger,

* "Sitting on his hind-paws, at the bank of a river or lake, he continues so motionless that he might be mistaken for the burnt trunk of a tree. He has sometimes deceived even the practised eye of an Indian. With his right paw he seizes with incredible celerity the fish which pass below him. What he does not eat he conceals, to take it during the remainder of the day. He seems to know that morning and evening are the only times for fishing."—Bettrami's Pilgrimage.

† The monkeys in Exeter 'Change were confined in a line of narrow cages, each of which had a pan in the centre of its front, for its food. But when they were all supplied, scarcely any ate out of its own pan, but thrust its arm through the bars, to rob its left or right-hand neighbour, though its own pan was exposed to similar depredation.

‡ Captain Franklin confirms the usual account of the beaver: "They have often been seen in the act of constructing their houses in the moonlight nights; and the observers agree that the stones, wood, or other materials are carried in their teeth, and generally leaning against their shoulder. When they have placed it to their mind they turn round, and give it a smart blow with their flat tail. They keep their provision of wood under water, in front of the house."—Journ. to Polar Sea, p. 91. ...." When a branch of a tree cut is too strong for one only to transport, several join in the work. They often pass several nights to bring down a willow from twelve to twenty inches diameter."....For the last century a colony of beavers has been established on a little river which runs into the Elbe, the Nuthe near Barby, whose habits M. Meyermek describes. They constructed a dike for their residence, with trees, which they placed in the stream, filling up the interstices with earth and rushes till it rose a foot above the water. M. Meyermek several times destroyed it, but they always rebuilt it during the ensuing night.—Bull. Univ. 1829, p. 108...."The insides of their houses are neatly plastered with mortar, spread and beaten firmly with their tails; and each individual forms its bed of moss, or of the tender twigs of box or fir."—Kerr's Linn. 223.

§ Mad'lle de Laistre described her weazel to Buffon: "It plays with my fingers like a little kitten, jumps on my head and neck, and if I present my hands at the distance of three feet, it jumps into them without ever missing. It distinguishes my voice amid twenty people, and springs over everybody to come to me. But it is impossible to open a drawer or a box, or even to look at a paper, but he will examine it also. If I take a paper or a book, and look attentively at it, he runs immediately upon my hand, and surveys with an inquisitive air whatever I happen to hold."

is it any other quality in animals who use the same precaution? Marmots do this.* So do the baboons and monkeys of Africa.† The wild asses likewise, and many other classes.‡ If the assembling in societies occurs among mankind from a sense of mutual wants, safety, and benefit, and from sympathies that we term moral, must there not be some feelings or notions analogous to these in those species of quadrupeds who voluntarily associate together?§ The social mouse is a pleasing instance of these sensibilities; these pair, form families, and live together as neighbours.‖

* The bobac, or Polish marmot, which inhabits the dry and sunny places of the mountains, from the Boristhenes to China, "go about in search of food in the morning and middle of the day, *placing a sentinel* to give warning of approaching danger."—Kerr's Linn. 251.... The mountain marmots have this precaution: "One stands sentinel upon a rock while the others gambol on the grass, or cut it in order to make hay. If the sentinel perceives a man, an eagle, or a dog, he alarms his companions by a loud whistle, and is himself the last to enter their hole."—Beaupl. Ukraine.

† The Ursine Cape baboons descend from the mountains into the plains to pillage gardens, and then place sentinels to guard against surprise.—Kerr's Linn. 64....The Chinese monkeys place a sentinel on some adjacent tree while they plunder the sugar-canes. He screams if a person is approaching; and then, each grasping as many canes as he can in his right arm, runs off on his three legs.—Bing. vol. ii. p. 80. The four-fingered monkeys also plunder together, and place a sentinel: the pigmy apes likewise.

‡ The wild asses live in herds, each consisting of a chief and several mares and colts, to the number of twenty sometimes. They are very timid, and provident against danger. A male takes on him the care of the herd, and is always on the watch. If they observe a hunter, the sentinel takes a great circuit, and goes round and round him, as if discovering something to be apprehended. As soon as he is satisfied of this, he rejoins the herd, and all set off with precipitation.—Bing. An. Biog. vol. ii. p. 131.

§ The llamas, among their native mountains, associate in large herds in the highest parts. While the rest feed, one watches as a sentinel. When he hears any intruder approach, he gives a kind of neigh, and the herd run off. After galloping to a considerable distance, they stop, turn round, gaze at their pursuers until these come near, and then again set off.—Bingl. vol. ii. p. 68.....The Siberian horses likewise plant sentnels.—*Ib.* 124....The Scythian antelopes seldom all rest together. Some are generally stationed on the watch; and when these are tired, they give a kind of notice to such as have taken their rest, who then rise and release the sentinels.—*Ib.* 96,....The sheep on the Welsh mountains graze in parties of about a dozen. One of these is stationed at a distance, to give notice of danger. If this sees any one advancing, it looks at him till he comes within 80 or 100 yards; and if he still approaches, it alarms its comrades by a loud hip or whistle, two or three times repeated, and all scour off to the steepest parts."—*Ib.* 134.

‖ "This species lives in families consisting of two parents with their

The beavers unite, from a distance, into societies, for the express purpose of building their habitations in vicinity to each other, and co-operate in their labour, like Dido's followers in the Virgilian picture of their founding Carthage, or like emigrants into the wilds of America, to build their log-houses and forest towns.* The marmots as assiduously join their skill and industry together, to form their social rooms, as any body of bricklayers and carpenters to raise the edifices they construct.† Several other species of animals also shape their habitations by concurring labour.

All the instances which occur, in these classes of beings, of co-operating action for some common end, show the intention and the desire to unite their efforts for that purpose, and, therefore, a mind, or a meaning and thinking power, that designs, perceives, comprehends, wills, and operates to

young ones, and of these families vast numbers reside together; the whole country being covered with little hills of earth thrown out of their burrows."—Kerr's Linn. 239.... The great bat, vampyrus subniger, "lives in societies of more than 400, in the hollow trunks of large decaying trees."—*ib.* 91.....The ring-tail macauco, lemur cotta, are in considerable societies.—Penn. Quad. No. 131.... Most of the pecora and gifres genera, and some of the bellinæ, associate in flocks or herds, seek each other's society, and have a visible pleasure in being together, even different species. I have been often amused with seeing horses and cows, of different fields and owners, mutually approach hedges and gates to each other; remaining for some time looking at and at times licking each other.

* The beavers of North America "associate together for carrying on their wonderful operations, in which they surpass the ingenuity of all other quadrupeds. They begin to assemble in June and July, from all quarters, till they form a troop of 200 or 300 near some river or brook. Here they make an embankment; cut the smaller trees into proper lengths for staves; fix these like piles, interweave them with smaller branches, beat earth into a kind of mortar with their feet and tails, ram it into all the vacancies, till they have made a solid dike 10 or 12 feet thick at the base, sloping to 3 at the top, with shallow gaps to let the water escape. Near this they build their cabins on piles, and wattle them with branches, and with two doors, one to go into the water, the other on land. These have sometimes 3 or 4 stories, holding from 18 to 30 beavers, and each village or community has from 10 to 20 cabins." —Kerr's Linn. 223.

† "The alpine marmots live together in societies of 5, 9, 12, or 14." —Kerr's Linn. p. 249. "They lodge together in subterraneous apartments, and their labour in collecting materials for these is carried on in common. Some cut the finest herbage, and others collect it. To transport this, one lies down *on its back*, and allows himself to be loaded, and extends his limbs for that purpose. Others trail him, thus laden, by his tail to the place." "I have often," adds M. Beaupland, "seen them practise this mode of conveyance, and watched them for several days." —Beaupl. Ukraine Church. Voy. vol. i. Bingley, vol. ii. p. 32.

produce it.* Individual instances of what in human beings we should call contriving mind, have been remarked in animals. The squirrel's mode of passing a river,†—the jerboa's provision for his escape if attacked in his retreat,‡—the opossum's mode of obtaining crabs which his paws cannot reach,§—the monkey's use of his tail as a hand or finger,‖—the Peruvian hare's two chambers for distinct uses,¶—the otter's** providing against the rise of the tide

* Thus the four-fingered monkeys, to pass from one lofty tree to another which is too far off for a leap, will form a kind of chain, by linking to each other with their tails; and then hanging down and swinging together with increasing momentum and sweep, till the lowest catches hold of the lower branches of the desired tree. As he fastens and ascends, he pulls the others up, each in succession doing the same. —Ulloa, Voy. South America; Bingley, i. p. 86.... Both wolves and foxes act with great co-operation; the former in their attacks, the latter in their depredations.... Elephants also concur in making great efforts to raise a companion out of a pit or trench.... Mr. Pringle mentions an instance in which a troop employed themselves part of a night to deliver one who had fallen into a water-ditch, and succeeded.—Menag. vol. vii. p. 100.... It is by the co-operation of the tamed that the wild ones are often taken..... A rat was seen at Oswestry, in 1828, to be leading a blind one to a stream of water, several yards off the building they frequented, by a piece of straw which he had put into his companion's mouth and pulled by his own.—Shrewsb. Chron.

† When the migrating squirrels come to a lake or river, they draw a piece of pine or birch bark to the edge of the water, mount on it, and abandon themselves to the waves, raising their tails to catch the wind. If this should blow too strong, they are overturned. The Laplanders eagerly collect those who are thus drowned.—Bing. An. Biog. ii. p. 39.

‡ The jerboa forms burrows under ground, of several yards long, in a winding direction, leading to a large chamber about half a yard below the surface. From this a *second passage* is dug to within a very little way of the surface, *by which they can escape* when threatened with danger.—Kerr's Linn. p. 273.

§ The Cayenne opossum lives chiefly on crabs. When it cannot reach them in their holes with its paws, it introduces its long prehensile tail to hook them out.—Kerr's Linn. 195.

‖ The four-fingered monkeys are peculiarly dexterous in the use of their tail. They can pick up with it objects so small as bits of wood or straw. M. Audebert noticed two of their actions with it. Coiling it round one of the branches of a tree, at Paris, one swung himself a few times backwards and forwards; and then, with this acquired momentum, darted into the next adjacent tree. With his tail he carried hay to make his bed, and spread it about with as much ease.—Audebert, Hist. des Singes. Bing. i. p. 87.

¶ The Peruvian hare digs holes under ground; and forms two contiguous chambers there. In one of these it sleeps (its bed-room); in the other, which is *lower* (its parlour), it eats its provisions, which it collects in the night-time.—Kerr's Linn. 277.

** The habitation of an otter is almost always made in the bank of a

or river,—the honey weasel's averting the glare of the sun,*—the monkey's imitation of the astronomers who were measuring the length of a degree in Peru,†—the Indian monkey's resolute mode of self-defence,‡—the bear himself finding out the plant that will heal his wound, and making and applying a plaster from it,§—the wolf's cautious reasoning amid his hunger and voracity,‖—are instances of this

river or brook, near which is a plentiful supply of food. In forming his habitation he exhibits great sagacity. He burrows under ground in the bank, always making the entrance of his hole under the water. He works upwards, and before he reaches the top he provides several holds or lodges, that, *in case of high floods*, he may have a retreat. He then makes a minute orifice for the admission of air; and contrives to place this little air-hole in the midst of some thick bush, the more effectually to conceal his retreat."—Bingley, vol. i. p. 267.

* "Towards sunset he issues from his hole. Near this, he sits upright, and holds one of his paws before his eyes, in order to modify the rays of the sun, and to procure a distinct view of the bees he is looking for." When he sees any bees fly, he knows that they are going home, and takes care to keep in the same direction, in order to find them. "He has besides, the sagacity to follow the cuculus indicator, a little bird, which, with an alluring note, guides him to the bees' nest."—Bingl. vol. i. p. 252.

† When Messrs. Condamine and Bouger were in this service, some large monkeys were admitted into their rooms, during the time that they were making their observations in the mountains. These animals, of their own accord, went through a series of imitations of their actions. They planted the signals, ran to the pendulum, and then to the table, as if to commit their remarks to paper. They occasionally pointed the telescope to the skies, as if to survey the planets or stars.—*Ib.* 94. This was mere imitation without knowledge; but it showed attention, memory, dexterity, and the intention and desire to do as the astronomers did.

‡ Monkeys exclude from their homes those of a different herd. A large monkey stole into the retreat of others at the pagodas of Cherinam. The males united to attack him. Seeing his danger, he ran to the top of a pyramid eleven stories high. The others followed. He placed himself firmly in a small round dome; and being superior in strength to any one, he seized them as they came up, and hurled them down to the bottom. The fate of three or four thus destroyed made the others retreat; and as soon as evening gave safety to his movement, he withdrew to another place.—*Ib.* 92.

§ When a bear is wounded by a ball, he gathers leaves and fills up the wound with them. The Kamtschadales state that they derive their medical knowledge from observing what herbs the bears apply to their wounds, and what method they pursue for recovery when languid and disordered.—Bingl. vol. i. p. 275.

‖ He is very mistrustful of snares, and "if he find a reindeer tied to a post to be milked he will not approach, lest the animal should be placed there only to entrap him; but no sooner is the deer set at liberty than he instantly pursues and devours it."—Bingl. p. 190.

sort. The wolf, with artful judgment, will take the babe from the mother's bed so gently as not to disturb her.* They also resolutely co-operate in their fatal attacks.† To know the names which have been given to them by their owners, and to come, when these are pronounced, to those who so call them, imply in animals memory, a connexion of sounds with ideas and actions, and an obeying will.‡ The attention of some to music, which I have already alluded to, has a claim to be called an intellectual sensibility.§ So has the impression which some receive from the menacing features of the human face.‖ The actions of the elephant and of the dog, which resemble those of thinking intellect, are

*Mr. Shepstone, from one of the Wesleyan settlements in South Africa, has recently stated the marked preference there of the wolves for human flesh, in their nightly visits. Calves and a fire separate the parent from the entrance; yet "the practice of this animal has been, in every instance, to pass by the calves in the area, and even the fire, and to take the children from the mother's kaross: and that, in such a *gentle and cautious* manner, that the poor parent has been unconscious of her loss, until the cries of her little one have reached her from without, a prisoner, in the jaws of the monster."—Miss. Reg. Dec. 1831, p. 531.

† "A little girl, about eight years of age, was reclining on the ground in the cool of the day, when four wolves rushed upon the place. One of them seized her by the head, a second by the shoulder, and the other two by the thighs. The people of the kraal with all possible speed flew to her help, and succeeded in releasing her."—*Ib.* p. 530..... The missionary states that forty instances of their attacks on mankind had occurred within a few months; but these wolves might urge that they had been tempted by man into this appetite for human flesh. "This boldness in the wolf, and his passing by every other sort of prey for a human body, must be attributed to the horrible custom of leaving the dead unburied, and to the frequent wars in this part of Caffraria. The late Chaka was a caterer to the wolfish tribe."—*Ib.*

‡ Mr. Hartley, in the isle of Egina, narrates, that, "passing by a flock of sheep, I asked the shepherd if he gave names to his sheep, and if they obeyed him when he called them by their names. I bade him call one; he did so, and it instantly left its pasturage and its companions and ran up to him with signs of pleasure, and with a prompt obedience which I had never before observed in any other animal."—Miss. Reg. 1830, p. 223..... D'Obsonville's ichneumon would come when called.

§ See before, p. 276. Dr. T. Shaw mentions the warral, an animal of the lizard kind, "to be so affected with music, that I have seen several of them keep exact time and motion with the dervishes in their circulatory dances; running over their heads and arms; turning when they turned, and stopping when they stopped."—Shaw's Travels in Egypt, p. 411..... Mr. Greaves's friend had several black lizards at Grand Cairo. "These, when the weather was hot, would, upon music, come out and run upon him. Of this music, they love the bagpipe best."—Greaves, Obs. Pyr. vol. ii. p. 523.

‖ It has been said that the elephant and dog are the only animals who

very striking; but are so familiarly known, and have been so often described, that I will only here recommend you to recollect them as very instructive testimonies of the nature and operations of the animal mind.* The orang outangs, likewise, which come nearest to us in form, at times evince some faculties and actions so analogous to our own, as to be only distinguished by the insurpassable limitation which appears always attached to them.† But all the simia tribes are confined to their native inferiority to us, and to their discordances from us, inflexibly and unalterably, in their minds as in their bodies. No time, and no arts, and no habit can convert the baboon figure, features, or skin into the feminine face and form which we love, or into the manly presence and body we admire; nor his imperfect mind into

understand looks, and that the dog only dreams; but I believe that cats, horses, and cattle are impressible by the countenance that threatens them.

* The dog mentioned in p. 280, of which Leibnitz was "un temoin oculaire," was at Zeitz in Misnia. A young child had heard it utter some sounds which he thought resembled German, and this idea led him to teach it to speak. At the end of some eight years it had learned about 30 words; some of which were tea, coffee, chocolate, assembly. It spoke only by echo, that is, after its master pronounced the word. It seemed to repeat only by compulsion, and against its own will, though it was not ill treated.—Leib. Lett. to Abb. S. Pierre. Op. vol. ii. p. 180. Dugald Stewart, p. 225.

† The orang outang of Borneo is not so large as that mentioned in Abel's Voyage to China.... Of Mr. Grant's, the following circumstances have been noticed:—He was grave, and seemed pensive and melancholy; but he was curious, and attentive to remark what passed. His actions were prompt. He could arrange very well his little concerns; but he shook his chain as if vexed, and kept in his tub like a Diogenes. He drank willingly milk, with a little tea, and ate bananas with pleasure. He learned to hob-and-nob with a glass of wine. He was mild, and rather kind; but a strange face sometimes frightened him. His greatest passion was curiosity to examine all things. He touched and turned them about, smelt them, and tried them with his teeth. Sometimes he played with some objects, and sometimes was angry with them, and tore or broke them. He learned to dance. There was no occasion to threaten him, like other apes, with a stick; but he showed a great superiority of intelligence over these. We could not avoid seeing a greater capacity for instruction in him than in the baboons and apes. When a dog came near him, he seemed surprised and alarmed, but showed no hostility or malignity to him, as monkeys do, who will leap on the back of the largest mastiffs. When some Hindoos of Bengal came in his sight, his gravity changed to fantastic and playful motions. After a woman had given him cold water instead of tea several times, he showed great vexation at it, and to know whether it was so, put his finger in. Observing this, she gave him *hot* water, which scalded him; after that, he always *put in a spoon* or piece of wood first, and *touched* the *spoon*. This action was very like human *reflection*.

our capacities and sensibilities. What they are they can only be for all succeeding ages in which they may exist. No brute animals of any kind, in any chronology of their being, have been found to possess the expanding and unceasing improveability of the human soul. It is this quality, never extinguished or extinguishable, though often dormant, which proclaims our spirit to be born for immortality; as the want of it makes it probable that their vital principle in all other material organizations, at least in their present forms and phenomena, is not intended to be perpetuated hereafter.*

Monkeys usually show some surprise at seeing themselves in a *looking-glass;* but this orang outang surveyed himself in it with curiosity, and tried to ascertain its hardness by biting it, as he would other things. He was called Maharajal, and listened when he was called.—Bull. Univ. 1830, vol. ii. p. 475.

* Mr. Logan has briefly, but neatly, sketched the real character of the animal world. "There are many qualities which we share in common with the inferior animals. In the acuteness of the external senses some of them excel our species. They have a reason of their own. They make approaches to human intelligence, and are led by an instinct of nature to associate with one another. They have also their virtues; and exhibit such examples of affection, of industry, and of courage, as give lessons to mankind. But in all their actions they discover no sense of Deity, and no traces of religion."—Serm. vol. i. p. 3.... The philosophic moralist Charron says of them kindly, and not untruly, "The man is wise who considers them, and who will make them his lesson and his benefit. In doing this, he will form himself to innocence, simplicity, liberty, and to that *natural mildness* which shines out in the brute creation, but which is altered and corrupted in us by our artificial inventions and excesses, which spoil what we have beyond them in our mind and judgment.... We shall often be instructed by their activity and industry.... There is always some intercourse between them and us—some relation and mutual obligation. We belong, both, to the same Master. They are of the same family as ourselves, and it is base to use cruelty to them. We owe justice to mankind, and favour and benignity to all other creatures who are capable of receiving them." —La Sagesse, l. i. p. 70.

Dr. Hartley has also thus benevolently pleaded in their behalf:— "These creatures resemble us greatly in the make of the body in general, and in that of the particular organs of circulation, respiration, digestion, &c.; also in the formation of their intellects, memories, and passions, and in the signs of distress, fear, pain, and death. They often likewise win our affections by the marks of peculiar sagacity; by their instincts, helplessness, innocence, nascent benevolence, &c. The future existence of brutes cannot be disproved by any argument, as far as yet appears." "And if there be any glimmering of hope of an hereafter for them,—if they should prove to be our brethren, and sisters, in the higher sense; in immortality as well as mortality; in the permanent principle of our minds, as well as in the frail dust of our bodies,—this would have a tendency to increase our tenderness for them."—Obs. on Man, vol. ii. p. 231, 404.

LETTER XV.

The oviparous and amphibious quadrupeds—the tortoise, crocodile, and lizard tribes.—A general view of their nature, qualities, and mental principle.

THE class of animals which is very peculiarly connected with those relics of their primeval races which our rocks and subterraneous strata have disclosed, is that which contains the oviparous quadrupeds—the tortoise, crocodile, and lizard tribes—and those without tails. These spring from eggs, without parental brooding, like fish and insects; and as they have left for our present knowledge of their ancient nature, amid the destructions they underwent, some important fossil remains of their bones and figure, they ought not to be omitted in our general review of the orders and economy of the primitive creation.

The oviparous quadrupeds present to us material investments of the animal mind and living principle, very distinct from the figures, limbs and functions of the other quadrupeds and kingdoms of nature, yet associated with them by several analogies. They have a heart, though it has only one ventricle. They have blood; yet it is not the red warm fluid, but a cold and pale one. They breathe, but with frequent and long suspensions, which no land or air animal could endure.* They have the same senses, but in feebler action and sensitivity, except that of sight.† Their brain is proportionally smaller. Their muscular motion, in some, is far less vigorous, though active in others. They require less food, and can remain a long time without any.‡ Their

* "This class of animals is distinguished by a body cold and generally naked; a countenance stern and expressive, and harsh voice. All have cartilaginous bones; slow circulation; they are deficient in diaphragm; do not transpire; are tenacious of life." T. Linn. v. 1, p. 638.

† "The class of oviparous quadrupeds are possessed of an equal number of senses with the more perfect animals; but all their senses, except that of sight, are so weak, in comparison with the viviparous quadrupeds, that they must receive much fewer impressions through them,—must communicate seldomer and less perfectly with external objects, and be less strongly and frequently excited to internal action in consequence of these." Count La Cepede, v. 1, p. 16. Kerr's Transl. . . . "Exquisite sight and hearing." T. Linn. p. 638.

‡ "They are able to remain a very long time without food. Some instances have been known of tortoises and crocodiles living a whole

manners are gentler; they exhibit no ferocity, and appear to enjoy a much longer and more tranquil life.* They usually inhabit the sea or its shores, rivers and their banks, marshes, pools, and other wet and moist places. They live or herd together, are generally inoffensive, and can be tamed, and become tractable and amusing.† The young never know their mothers, nor receive any nourishment from them. Hence they are what they uniformly show themselves to be, from the impulses of their assumed principl of life and provided organization; and independent of al tuition.‡ La Cepede divides them into three genera classes, which he arranges separately into such divisions as their distinct kinds seem to make reasonable;§ and these are subdivided into their respective species.‖ They form the amphibia of Linnæus, who distinguished them into two orders,—reptiles with feet, and serpents without; and into twelve genera.¶

year though deprived of all sustenance." La Cep. 30. . . "They can live a long time without food." T. Linn. 638.

* "Most of the oviparous quadrupeds are long-lived. We are certain that the large sea tortoises, and the other species, live to a very advanced age." p. 59. . . . . "Perhaps even more than a century." p. 115. . . . . "The mud tortoise lives at least 80 years. From this great length of life, the Japanese adopt the tortoise as an emblem or hieroglyphic of happiness." p. 116.

† "For the most part the manners of the animals of this class are gentle, and their characters are free from any degree of ferocity." La Cep. 48. . . "Their tempers are often susceptible of being considerably modified by culture." Ib. p. 58.

‡ "They have no enjoyment of parental affection. They abandon their eggs immediately after they are laid." La C. 54. . . . "Thus the young of oviparous quadrupeds receive from their parents neither nourishment, care, nor education. They neither see nor hear any action or sound to imitate." Ib. 57.

§ He classes them, in his Supplement to Buffon, into—I. tortoises; II. lizards; III. oviparous quadrupeds without tails: which he divides thus—the 1st into sea tortoises, fresh water, and land ones; the 2d int crocodiles and lizards; the 3d into frogs and toads. La Cep. Ov. Quad v. 1 & 2.

‖ He made 6 species of sea tortoises, and 26 of the others; 3 distinct species of the real crocodiles, 8 of resembling lizards; 14 other species of lizards with round tails; 23 more species of the kind which he heads with the chameleon; 5 others, the flying lizard; and 6 others, which begin with the salamander. He enumerates 20 species of frogs, and 14 of toads. Ib.

¶ To the reptiles who "have feet and naked ears without auricles, he assigned 5 genera,—the tortoise; the dragon, or flying lizard; the lizard tribe, including the crocodiles; the frog and toad genera; and one which he called siren. These, in Dr. Turton's edition of the System, comprised in the first, 3 species of marine turtles, 18 river turtles, and 12 land tortoises; in the second, 18 toads and 18 frogs; the fourth has 2 crocodiles

The Creator has made nothing that is unuseful—nothing so insulated as to have no relations with any thing else—nothing which is not serviceable or instrumental to other purposes besides its own existence—nothing that is not to be applicable or convertible to the benefit of his sentient creatures, in some respect or other. The mineral has a connexion of this sort with both the vegetable and animal kingdoms, and these with each other.* The same principle has been pursued throughout the animated classes of nature. No one species of living being has been formed only for itself, or can subsist in absolute uselessness to others. This is one grand purpose for causing so many races of animal being to subsist on each other. By this system, each enjoys the gift of life, and each is made to contribute, by the termination of that gift, to the well-being of others. Fishes, are thus useful to each other, to many birds, to some animals, and to man. Birds have their period of happiness for themselves, and are serviceable to others of their kind, and to man, and to some quadrupeds, in their mode of death, instead of mouldering through corruption into their material dissolution. Quadrupeds have the same double use in their existence: their own enjoyment; and the benefit at their death, to those of their own order, and to the birds and reptiles, worms and insects, that have been appointed to derive nutrition from their substance. All the kingdoms of nature have been likewise so constructed as to be beneficial to the human race, not as nutriment only, but in the thousand conveniences to which they are convertible. The amphibious order of nature is no exception to these general results. Its various genera contribute their proportion to the common stock of mutual utilities. They have their own

nd an alligator, and 78 lizards. The serpents are arranged into 7 genera, with numerous species.

* The matros, or wild cotton tree, affords an instance of the connexion y which the various parts of nature are linked together. It grows in Juba to a height of 100 feet, of which, for the first 65 feet of its elevation, the whole trunk, which is 76 feet in circumference at the base, has not a single branch: but above this distance from the ground, the branch emerges and covers a diameter of 165 feet. This immense tree is itself a world. It shelters and feeds myriads of insects. Several parasitical plants attach themselves to it. Wild pine-apples grow at the top. The vine on its boughs, letting down its ramifications to the earth, enables rats, mice, and the opossum to climb to its pine cups, which are full of rain water. The wood-louse forms extensive republics at the juncture of some of its branches, and constructs two covered ways of mortar to the earth, one to descend by, and the other to go up. Lit. Gaz. No. 679.

gratification from their personal existence; they contribute by their substance to the maintenance of others of their fellow creatures; and some of their genera serve to multiply the conveniences and pleasures of man. He derives advantages from all that exists, in as much larger a degree to any other animal, as he is superior to any in his intellectual exertions and universal capacity.

The first order, the tortoise genera, are the most immediately serviceable to mankind. The flesh of the sea turtle i both a valued delicacy and a useful medicine;* and th shell of one species furnishes society with that rich an beautiful material which forms our tortoise-shell ornaments and conveniences.† It is a gentle and harmless animal, without any means of hurting others. Its protecting shell forms both its house and its armour, and enables it to defend itself by a patient and passive resistance, without disturbing its natural mildness of temper.‡ It takes for its occasional subsistence grass, sea-weeds and shell-fish; but, in general, it requires but little food, as it can subsist for many months without any. The green sea turtles like to be together, and therefore assemble in numbers in the same locality, content with their mutual vicinity, and seeking no further association.§ They can remain long under water,

* "The flesh of the green tortoise contains a softening, diaphoretic, and highly nourishing juice, the good effects of which I have often experienced. It makes an excellent soup, which is considered as a sovereign remedy in scurvy and pulmonary disorders." Note of De la Borde, king's physician at Cayenne. . . . Hence it is "an approved remedy against the diseases which proceed from a long continuance in a crowded ship." La Cep. v. 1, p. 80.

† It is the hawksbill tortoise, testudo imbricata, which furnishes "that beautiful substance with which, even from the most remote antiquity, the sumptuous palaces of the great have been adorned, though it has now given place to the brilliancy of gold, and confined to elegant toys." La Cep. 140.

‡ "Defended by armour of very strong bone, which can sustain excessive loads without breaking, so as to have nothing to fear; and at the same time having no means of offence, they can do no injury to others. Mildness of temper, and passive force to resist against injuries, seem their distinguishing features; and it was perhaps in allusion to these qualities that the Greeks made it a companion to the goddess of beauty." La Cep. p. 90. . . . At Ælis there was a temple to the celestial Venus: her image was of ivory and gold, made by Phidias: one of her feet he placed upon a tortoise. Paus. Elian. l. 6, p. 392.

§ "Being able to live, even for more than a year, entirely without food, they flock peaceably together. Drawn together to the same spots by the same necessities and similarity of habits, they live amicably in the same place, without forming any kind of society." La Cep. 89. . . ."

and sleep upon it.* They are periodically travellers, for the sake of depositing their eggs in convenient places; and sometimes, for other reasons, extensive emigrants; for they have been found on the coasts of France, and also of England.†

The land tortoise has the same gentle and peaceable manners. It can live without food,‡ and probably does so, like many if not most of the fish, except at certain periods. It enjoys a great length of life,§ and has its living principle so essentially within its body, that it can subsist and move without either brain or head.‖ This class of animals were thus made to be in the waters, what the sheep are on the hills and plains,—harmless, gentle, patient, and useful;¶ one

"One small kind, the ferax, in the rivers of South America, about 70 pounds weight, is rather fierce. It defends itself by biting." T. Linn. 642.

* The midas species is the largest of its tribe. It inhabits the south seas; and is so strong as to be able to run with a load of 600 pounds weight, and to move with as many men as can sit upon its back. When turned up on land, it is unable to move. It lays numerous round, membranaceous eggs; as many as 1000, which it deposits in the sand, and sits upon by night. Its flesh and green fat is delicious to the taste, and greedily sought after by scorbutic sailors. It feeds on sepia and shell-fish." T. Linn. 1, p. 641.

† La Cep. 119. Tortoises have been found at sea, more than 700 leagues from any known land. Cook's 3d Voy. . . . . "M. De la Borde has seen many tortoises floating at sea 300 leagues from land. Some sea tortoises are occasionally caught on the coast of Languedoc and Provence." They "have been caught near the mouth of the Loire." La Cep. 121, 2. . . . . In 1752, one weighing 800 lbs. was taken in the harbour of Dieppe, having been driven there by a storm. Ib. 123. . . . . In 1810, Mr. Bingley saw one that had been caught near Christchurch, Hants. An. Biog. v. 3, p. 147.

‡ "Dr. Garden kept one, weighing above 25 lbs. near three months, in his house; during which time he could never perceive that it took any nourishment, though different articles were presented to it for food." La Cep. 174. . . . . G. Blasius kept one for ten months, during which time it neither eat nor drank. Blas. Obs. Anat. p. 64. . . . . Mr. White's had the greatest appetite in the height of summer, and eat very little in spring and autumn. White's Selborne.

§ M. Cetti saw one in Sardinia, which had lived 60 years in one house. Hist. Anat. Amph. . . . . Archbishop Laud's was alive in 1753, or 126 years after its introduction. Another lived at Lambeth 107 years. The one at Peterborough was 220 years old. It had been contemporary with seven successive bishops. Murray's Exper. Researches.

‖ In experiments which revolt our best feelings, F. Redi removed the whole brain from a common land tortoise. The eyes closed, to open no more; but the animal walked as before, but as groping its way for want of vision. It lived nearly six months after. Another, which he decapitated, continued alive for several days, though it had lost much blood. Redi. Obs. Anim. Viv. p. 126.

¶ "The manners of the tortoise are as peaceable as its motions are

of the most pleasing forms of character of all animated being; the truest representative and surest producer of personal and social happiness.*

The lizard division of the amphibia presents to us as its leading class, the formidable crocodiles—a name to which dread and aversion are, by the hasty prejudices of our defective knowledge, almost inseparably attached; for, although this class of creatures is the largest of all known animals, except the elephant, the hippopotamus, and the whale, and a few enormous serpents,† yet it is neither a erce nor a cruel animal, nor ever purposely or unnecessa ily injures. It seeks its appointed prey when hunger urges it; but destroys only for food, and has no passion or malignity.‡ In its general form, it is extremely similar to the other lizards, but with distinctive characters peculiar to itself. The mouth is enormously large, opening even beyond its ears, with jaws that are sometimes several feet

slow. Hence it is easily domesticated; and is an agreeable object in gardens, where it destroys noxious vermin." La Cep. 190.

* The tortoise observed by Mr. G. White, scooped slowly out for itself in the ground a winter cave or residence. It was a diurnal animal, and never stirred after dark. It could refrain from eating as well as breathing for a great part of the year; but during the height of summer it fed voraciously, devouring all the food that came in its way. Hist. Selb. 181. .... "It goes under the earth from the middle of November to the middle of April; but sleeps great part of the summer; for it goes to bed, in the longest days, at four in the afternoon, and often does not stir in the morning till late. It retires to rest on every shower, and does not move at all in wet days." Ib. 298.

"Of the one at Peterborough, the favourite food in spring was the flowers of the dandelion, of which it would eat 20 at a meal; or a lettuce; but if both were put before it, the dandelion was preferred. It sucked greedily the pulp of an orange. At the end of June it looked out for fruits; esteemed most the strawberry and the gooseberry: of the latter, it would at times take a pint. It would not take animal food, nor any liquid. It weighed thirteen pounds and a half; but moved with ease under a weight of 18 stone. During a thunder storm in 1813, it lay under the shelter of a cauliflower, apparently torpid." Murray's Experim. Researches.

† La Cep. p. 237. "Nature" [the author of nature] "has committed the government of the shores of the seas, and of the large rivers between the tropics, to the crocodile." p. 236.

‡ "Incapable of violent appetites, it is never actuated by ferocity." La Cep. 239. .... Aristotle had remarked this—"Though it lives by prey, even sometimes devouring mankind, this instinct is never exerted, as has been alleged of the tiger, to gratify an appetite for cruelty, or a thirst of blood, but solely to satisfy the most necessitous wants. Its power is not combined with cruelty and rapine. Like the whale, it only destroys to preserve its own existence, and to enable it to reproduce its kind." La Cep. 240. .... "The French soldiers in Egypt are said to have set the crocodiles at defiance, and were not once attacked by them." Bingley, v. 3, p. 174.

long. Its teeth, about thirty in each jaw, pass between each other when the mouth is shut, and have others of a very small size, in their socket, to replace their first ones. The lower jaw is alone moveable; and having no lateral motion, they mostly swallow what they take without mastication. They have a larger proportion of bile and gastric juice than any other animal;—a proof that these fluids are or may be innocent of the imputed charge of producing passion, irriability, cruelty, and ferocity—as the crocodile, with such a uperabundance of the hepatic stimulants, has not these noral perturbations.

They are sometimes thirty feet long.* Their whole body is covered by strong, hard scales, except the top of the head, and can be only wounded between the rows of these, which are impenetrable by a musket ball, unless it be fired very near, or the piece be very strongly charged.† Having no lips, their teeth are always bare; and from this peculiarity, though they be walking or swimming with the utmost tranquillity, the aspect seems animated with rage.‡ Another circumstance that contributes to increase the terrific nature of its countenance, is the fiery appearance of its eyes, which, being placed obliquely, and very near each other, have a malignant aspect. Over its hard and much wrinkled eyelids is an indented rim, resembling an eyebrow drawn into a menacing frown.§ Its brain is extremely small. Its tail and its webbed hind toes, acting like fins, assist its swimming. Its figure being flattened laterally, with some resemblance to an oar, enables it to cut the waters with great swiftness, and with astonishing velocity

* La Cep. 244. Hasselquist describes a female of this length. Voy. Palest. . . . . Barbot found some on the Gambia, and Smith at Sierra Leone, of that size; but in general they are less. Catesby mentions hose in North America and Jamaica as 20 feet; Keeling, one at Madascar as 16. The one at Paris was nearly 14 feet long. La Cep. 256, 7.

† Labat. Voy. v. 2, p. 347. M. La Borde says that musket balls will only pierce them under the shoulders; but they may likewise be wounded in the belly and near the eyes. La Cep. 250.

‡ La Cep. 24.

§ La Cep. "This genera aspect of malignity and hideousness has contributed greatly to promote a reputation for insatiable cruelty which some voyagers have attributed to this animal." Ib. 246. . . Dampier experienced how inoffensive this class of animals is. When in the Bay of Campeachy, as he passed through a swamp, he stumbled over an alligator. He called out loudly for assistance, but his companions ran away. Recovering himself, he fell over another; and again over a third; but they did not molest him. He says he never knew them attack a man, but often saw them run away from his sailors. Damp. Voy.

when about to seize its prey. On land, it can overtake a man in direct running; but if he turn quickly round into a circle, he escapes with ease, as the animal cannot so rapidly wheel round its great length of body.* Its longevity rather exceeds that of the tortoise genus.† When pressed with hunger, it devours mankind; and the large ones even attempt to leap or scramble into boats during the night, and in some places use their tails to overturn small skiffs, and then seize on the men or animals within them.‡ It has not been discriminated at what times or from what causes crocodiles acquire this voracity, for they often subsist a long time without any sustenance; and this fact leads us to suspect a specific urgency or causation for cravings, that are inconsistent with such a natural power and exercise of abstinence.§ In the colder climates they are torpid in the winter, and bellow like a bull when they wake into sensitivity from this state.‖ They congregate together in numerous assemblies, but not for any common purpose, like bees or beavers; nor, like seals, from affection.¶ Yet the habit shows that they have a gratification from each other's society; and their not meeting for any specific co-operation, rather implies that a pleasurable sympathy, in seeing and moving with each other, is the real motive of the association.** They abound chiefly between the tropics; but are met several degrees to the north of the one,

* La Cep. 271.

† "We have reason to presume that the life of the crocodile should extend beyond that of the green tortoise, or more than a hundred years." La Cep. 267.

‡ La Cep. 269, 272. Hasselquist relates that in Upper Egypt it often devours the women who come to draw water from the Nile, and the children who play on the banks. Voy. Palest. p. 347. . . . . In places where dead bodies are thrown into the rivers, crocodiles may be trained to seek human flesh.

§ "They are often obliged to fast for a long while, even at times for some months, without food. In this situation, they often swallow small stones and bits of wood." La Cep. 273. . . . . Mr. Brown frequently saw crocodiles live several months without any food. They had been put into ponds, with their jaws tied together with wire; and came often to the surface to breathe. Brown Nat. Hist. Jamaica, p. 461.

‖ Catesby Carol. 2, p. 63. . . . . La Cep. 275.

¶ La Cep. 276. Adamson, in the Senegal river, saw more than 200 swimming together, with their heads just above water, resembling a great number of trunks of trees floating down the river. Voy. Senegal.

** La Cepede justly remarks, "This habit of living together is an additional proof that the character of cruelty and ferocity has been falsely ascribed to them." 277.

and to the south of the other. They are smaller, however, as more distant from the equator.*

The other lizard tribes are small and pleasing animals. Some are beautiful in their colours.† The guana species is highly interesting.‡ The green lizard excites the admirer into the poetry of feeling and description.§ Its varieties are most striking.‖ The gilded lizard is not less attractive and gratifying.¶ All are very gentle and harmless, good tempered and peaceful. They also have the property of living without food;** and that of reproducing a limb or tail that has been mutilated.††

* La Cep. 281. The Count considers the crocodiles of the Nile and of America, which Linnæus separates, as of the same kind. But he makes distinct species of the black crocodile of Africa (described by Adamson, p. 73) and of the one called gavial, in the Ganges. This last is mentioned by Ælian; but "Mr. Edwards was the first modern naturalist who has mentioned it." La Cep. 300.

† In South America "an infinite variety of beautiful flowers is eclipsed by the more brilliant plumage of numberless birds. But still more brilliant colours, because reflected from more dense and polished surfaces, adorn the scales of the large and beautiful lizards, which are seen on the tops of the trees, usurping part of the dwellings of the birds." La Cep. 334.

‡ The guana lizard is distinguished for the beauty of its colours, and the splendour of its scales—yellow, green, and black, shining as highly varnished. 335—7.

§ The green lizard has all the lustre of the emerald. "The eye is never wearied by the delightful green of the skin. It fills the eye with lustre, but without dazzling. It is equally agreeable by its softness, as it is beautiful by the elegance of its reflected lights. It seems to mix with the surrounding air, softening away by gentle shades. Equally delightful in the full glare of sunshine, or in the evening's feebler ray, it continually presents to us the most delicate sweetness in its tints." La Cepede, 386, 7.

‖ "The colours of this species are subject to variety. It is chiefly in the warm countries that it shines in all its superb ornaments, like gold and precious stones. In these countries it grows to a larger size, sometimes 30 inches in length." Ib. 387.

¶ "The general colour is silver gray, clouded with orange, growing whiter at the sides. Like most other animals, the brilliancy of its colours ades after death; but, while animated by the vital warmth, they have a very splendid appearance, like burnished gold." La C. v. 2, p. 55, 6.

** Marcgrave says that he has seen the tupinambis live seven months without food. . . . Brown relates that he kept a full grown guana for above two months, and that it was never observed to eat any thing, but seemed to lap up small particles floating in the air, with its tongue, like the chameleon. Nat. Hist. Jam. p. 462. . . . The chameleon "can live a very long time, sometimes almost a whole year, without food." La C. v. 2, p. 24. . . . . Hasselquist found the remains of butterflies and other insects in the stomach of one he opened. Voy. Palest. 349.

†† The tail grew again in the tupinambis. La C. 329. . . . So in the nimbis lizard. p. 377.

The chameleon is distinguished from all animals by an ocular peculiarity which no other creature possesses. Each eye has a separate motion.* It is also remarkable for its viscous tongue, and changeability of colour. All its motions are extremely slow †

Two species emit a liquor which inflames, or has venomous effects.‡ Another has the singularity of being an occasional duellist, or combatant.§ The most remarkable of the other lizard genera are, the flying lizard and the salamander.

The flying lizard is the nearest resemblance to the fable dragons of antiquity, and of our old romances, that nature contains; but it defeats the identity with these celebrated monsters, by its smallness and harmlessness. It seldom exceeds a foot in length, and it is a weak animal, "perfectly innocent and peaceful." It flies from branch to branch of its tree, feeding on the ants, flies, butterflies, and other insects that it can take; and can flutter from one tree to another, within thirty paces.‖

* "They are each moveable independent of the other, so that one eye sometimes looks forward while the other is turned backward; or one looks up, while the other views things below." Le Bruyn. Voy. au Levant. . . . "By this means, the animal enjoys a much larger field of vision than it could have without this uncommon power." La. C. v. 2, p. 9.

† It is paler at night, and white after death. "Fear, anger, and heat, seem to be the causes of its changes of colours." La C. 20. It is brighter in motion, and in the sun, and when handled. Ib. Hasselquist ascribes the variation to its bile. p. 349.

‡ The spitting lizard, lacertus sputator, of St. Domingo, is but one inch long in body, and one more in its tail. It climbs among the beams of houses, and when not disturbed does no harm, but it is easily irritated, and then ejects a black saliva to some distance, which inflames and swells the part of the body it falls on. The evil is readily cured by washing with rum or any spirits, especially mixed with camphor, which is the usual remedy on a scorpion's sting. La Cep. 2. p. 79. . . . . The geeko of Egypt and India emits a yellow liquor from its mouth when excited, which is a mortal poison. The bite is also deadly, and the contact of its feet is perilous. It leaves a dangerous venom on what it runs over. Its name is given to it in imitation of its cry before rain. b. 85—9.

§ The strumous lizard, l. strumosa, of Mexico and South America. It is very familiar with mankind, climbs on the tables, and runs over those sitting at them. Its motions and attitudes are agreeable. But "when two of this species meet, they sometimes fight with great violence; their throat inflates, their eyes seem on fire, they attack each other with fury, and the victor devours the conquered." This is probably connected with peculiar seasons, as others, probably of a different sex, "often stand quiet spectators of this combat." La Cep. 72, 3.

‖ Its wings are membranous expansions from its side, extended by six cartilaginous rays, which spring horizontally from its backbone.

The salamander has long lived in popular fame as much as the fictitious dragon; but has a real entity, though it does not verify the many fables that have been attached to it. Instead of living in fire, it delights in cold, damp places. It retires, sometimes in great multitudes, into the hollows of old trees, and under the roots of hedges; and can remain a considerable time in water. Some have been kept in this for six months without food; but it spends the greatest part of its life in holes under ground, or beneath stones and rotten trees, appearing to dread the heat of the sun.* When touched, it covers itself all over with a milky fluid, which is acrid to the skin; and it does so the instant it touches fire, but never in such abundance as to extinguish the smallest flames.†

Frogs and toads are too well known to you, to be particularized in these letters. I will only mention of the latter, that one species is called the musical toad, because in the evening, and during the whole night, at Surinam, it makes a musical kind of croaking.‡ Another is termed the laughing toad, because it emits a clear sound, like a man laughing, in the fenny places of Germany and Helvetia.§ A species near the rivers of the Caspian, as evening advances, also utters a voice like a human being in some risible humour.‖ The beaver, otter, and badger, are amphibious creatures, but not oviparous. They bring forth their young alive.¶

On contemplating creatures of a different form and habits from the rest, we are led to inquire if they display an animal mind and feelings like the others; or whether they possess a different sort, or are without any. To this question, nature gives us a distinct and satisfactory answer. The amphibious and oviparous quadrupeds exhibit in their actions, analogous phenomena to those of the other orders

Their structure, somewhat triangular, is very similar to the fins of fishes.

† is about Java, and other parts of Asia, Africa and America. La C. 32—4. It is called the draco volans.

* La Cep. 142—6.

† Maupertuis made many experiments on it, and found that it was subject to the action of fire, like all other animals. Mem. Acad. Scien. 1727. . . . its colour varies. Those found in the marshy woods of Germany and on the Alps, were black. La Cep. 144.

‡ Turt. Linn. v. 1, p. 648. Rana musica.

§ Ib. 649. Rana bombina.

‖ The jocular toad, r. ridibunda. It is very large, and often weighs more than half a pound. Ib. 651.

¶ Mr. Kerr has collected some of the most curious facts on the beaver, in his Linnæus, p. 222—6; on the otters, 173, 4; and succinctly on the badger, 187, 8.

and classes; but modified by their own peculiarities of structure and circumstances. There seems to be only the same animal mind at work in a diversified frame. The turtle, or sea tortoise, seeks to lay her eggs in the proper place, and at the fittest depth, with every appearance of what we deem foresight, and selecting, and therefore comparing judgment.* She exerts a manifest choice, combined with some previous knowledge or instantaneous discernment of the suited localities. She has the mental power of perceiving that the part she fixes on is adapted to her purpose; and that the sea she floats in will not accomplish it. She resolves to quit the fluctuating waves for a steady and sandy shore;† and perseveres in this determining will and judgment for a voyage, often of some hundred miles, until she can reach the spot, where her oval embryos may be placed most congruously for the animation and welfare of her future offspring.‡

The LAND TORTOISE gives sufficient indications of mental sensibility in its dissimilar habits. It makes for itself, by its own foresight and reasonable anticipation, a winter burrow or retreat from the cold. It perceives the approach of wet weather before we discern it. It distinguishes and recognises the persons who do acts of kindness to it.§ It

* She *prefers* fine gravel and loose sand not mixed with marine productions, where the heat of the sun may more easily hatch them. In this, *out of the reach* of the highest floods, she *digs*, by her fore paws, one or more holes, a foot wide and two feet deep, in which she usually deposits 100 eggs. To conceal them, she covers them with a layer of sand, sufficient to prevent their being seen by any animal, but *so thin*, as to permit the full influence of the sun's heat for warming and hatching them. She lays three times a year. They almost always choose the night time for laying them. La Cep. 93—6.

† "As a loose sand is necessary, they choose in an especial degree certain coasts, which they find to be more commodious and less frequented; consequently safer than others; and even make very long voyages from their feeding places, on purpose to come at these preferred spots." La Cep. 96.

‡ "Those which lay their eggs on the Cumanas near Cuba, have above 100 leagues to come from their usual haunts. These islands afford the particular shore which best answers their purpose, and on that account are so much frequented by tortoises as to have received the name of the Tortoise Islands. Those which pass great part of the year on the Gallapagos Islands in the Pacific, come as far as the S. W. coast of America to lay; a distance of more than 200 leagues. Those which deposit on the Island Ascension, must come a much longer journey, as the nearest land is 900 miles distant." La Cep. 97.

§ Mr. G. White remarked this fact of his Sussex tortoise: "On 1 Nov. it began first to dig the ground, in order to the forming of its winter hybernaculum, which it had fixed on just beside a great tuft of hypaticas.

knows, like rational beings, how to refuse the evil and choose the good;* and it attains, by its own observation, to perceive how it can remove what it dislikes, and do the proper action accordingly.† The numerous congregations of these animals which our navigators have remarked, indicate a mutual gratification from such associations; from being together. This pleasure and preference arise in us from the kindly sympathies and social sensibilities of our nature. As like effects imply resembling causes, we are scarcely justified in denying to animals, who seek and move to be in society with each other, some feelings of the same sort with those which actuate us to the same end. Their general conduct has the appearance of prudence, regularity, and perseverance.‡

The kind and submitting habits and tractability of the formidable CROCODILE, and its self adaptation to the sportive humours of the child, are indications of mental volition, of self-government, and of an acquired self-coercion of former habits and dispositions.§ To see the crocodile

Nothing can be more assiduous than this creature, night and day, in scooping the earth, and forcing its great body into the cavity... If attended to, it becomes an excellent weather-glass; for as sure as it walks elate, and as it were on tiptoe, feeding with great earnestness in a morning, so sure it will rain before night... I was much taken with its sagacity in discerning those that do it kind offices; for as soon as the old lady comes in sight, who has waited on it for more than thirty years, it hobbles towards its benefactress with awkward alacrity, but remains inattentive to strangers." N. H. Selb. 182. ... So the Peterborough tortoise: "The gardener, who generally fed it, told me that it knew him well, and would watch him attentively at the gooseberry bush, where it was sure to take its station while he plucked the fruit." Mur. Exper. Res.

* The Peterborough tortoise "had its antipathies and predilections. It would eat endive, green peas, and even the leek; while it positively *rejected* asparagus, parsley and spinach. In June it ate currants, raspberries, pears, apples and peaches, the riper the better, but *would not taste* cherries. I could not get it to take the *root* of the dandelion, nor any root; neither milk nor water." Mur. ib.

† "When a leaf was moist *it would shake it* to expel the adhering wet." Mur. ib.

‡ "Its habits are constant and regular. Possessing more patience than activity, it is never affected by violent passion. Having more prudence than courage, it seldom attempts defence when attacked; but employs all its strength to fix itself to the spot." La Cep. 90.

§ "In the Rio San Domingo, likewise on the west coast of Africa, M. Brue was astonished to find the crocodiles perfectly harmless; insomuch that children played with them, mounted on their backs, and even beat them, without danger or any appearance of resentment. This gentleness of disposition proceeds, probably, from the care which is taken by the natives to feed them and treat them well." Voy. to Bissao Isl. ... M. De la Borde saw crocodiles in Cayenne kept in ponds, where they

as docile as the elephant, and gentle and harmless like the cow, is a fine specimen of terrible power becoming, by its intellectual regulation, a good humoured and tractable playmate. What compulsion of his usual will, and what concurring power of mind, he must exert to make this mild demeanour habitual to him, we may infer by recollecting his dissimilar habits and overwhelming strength.*

The general mildness and docility of all the LIZARD tribe; the domesticity of some; their universal combination of great activity with perpetual gentleness; the visible attachment of many to mankind; and the same ability in all, display feelings and dispositions which approach the highest degree of moral character that animal nature can attain.† It wants the wisdom of the human race to guide its greater energies; but the mild and peaceable and pleasing regulation of its diversified powers, for its own comfort and for harmlessness to others, is an attainment of which

lived without doing any harm, even to the tortoises kept in the same ponds, and fed along with them on the refuse of the kitchens. La Cep. 278. . . . Aristotle mentions that to tame crocodiles, nothing is more necessary than to supply them abundantly with food. The want of this is the only cause of their being dangerous. Ib. 279.

* "The crocodile of the Nile, 18 to 25 feet long, is of amazing swiftness, voracity, and strength; smells of musk, roars hideously, devours men and other large animals: swallows stones to prevent hunger; overturns boats when taken in nets; is not to be killed by a musket ball, unless struck on the belly; is *destroyed by tobacco;* seldom moves but in a straight line, by which means it is easily avoided." T. Linn. p. 656.

† Thus the dispositions of the guana species are extremely gentle and harmless. It runs with astonishing agility along the highest branches of the trees; but soon becomes tame, and even familiar. La C. 340, 3, 7. The Amboyna lizard, "though extremely timid, flying at the smallest noise, has gentle and inoffensive manners." p. 361. . . . The dispositions of the American agama, are very gentle. p. 368. . . . The nimble lizard, whose motions are so quick, and who "runs with such swiftness as to disappear as quickly as a bird in the most rapid flight, sports innocently among the flowers, and gives pleasure by its beauty and harmless nature, and by the agility of its motions." . . . "This gentle and peaceful little animal, excites no sensation of fear. It escapes indeed for the most part, when any one endeavours to take hold of it; but when taken, it makes not the smallest attempt to bite or offend. Children use it as a plaything, and it even becomes familiar. It seems anxious to return the caresses which are bestowed upon it, and approaching its mouth to the mouths of those who fondle it, will imbibe their moisture there." La Cep. 375, 6. . . . The chameleon is also "in its manners so very gentle, that a person may push his finger into its mouth, and yet it makes no attempt to bite." Prosp. Alb. La C. v. 2, p. 14. . . . . The gilded lizard, mistaken for a salamander, has been "very industriously persecuted; on which account, perhaps, it is extremely timid, and always flees the approach of mankind." Ib. 58. . . . While the roquet lizard "affects the company of mankind." Ib. 68.

all its classes seem capable. Every species has been found tameable to this important proportion of self-government; with such exceptions only as rather prove, that we have not yet discovered the right means of their tuition, than their actual intractability. Early training, sufficient food, kind treatment, and the absence of all provocation and excitement, appear to be the moral spells that mitigate and transform them. These give them the knowledge and the experience, of which, in their wild state, they are destitute In that they are surrounded with enemies, or with danger with want; with inconveniences; with irritations; an with frequent sufferings. These alarm, excite, and exasperate, till the savage emotions become the habit of their bodily frame, and ferocity or fear their daily character. But human training, judiciously conducted, places them under the care, the friendship, the assistance, and the protection of man. Want, danger, and hostility, then agitate them no longer. Their former stimulants operate no more. They find food, and peace, and comfort from their human owner, and within his domain. Then the same animal reason which in its first natural operations made them wild and fierce, by the same natural operation, under new circumstances and with new knowledge, causes them to be gentle, tranquil, and obedient. It is the same mind, acting on the same principles and with the same judgment, but in very different positions, and upon its more recent and additional sensations. We may add that the wild beast and the tame are but the counterpart of the savage and the civilized divisions of the human population. The early tiger Saxon and the accomplished Englishman, the ruthless Pict and the intelligent Scotsman, are the two similar contrasts of such altered character, which our own improved and yet improvable island presents to our contemplation. Thus the New Zealand cannibal, now the rival of the wolf, the leopard, and the shark, may yet become the polished, the scientific, the moral, and the Christian European. Otaheite and Owyhee have already begun this consoling melioration.

The pleasure which several lizards display on being caressed by human kindness, implies sensibilities or impressibilities so like our own, that we can hardly give them any other denomination;* and this similitude is increased by

* The Mexican lizard, l. orbicularis, the tapayaxin, though covered with prickles, "never attempts to do the smallest injury. It becomes readily tame, allows itself to be handled, and even seems fond of being

their apparent gratification, shall we call it vanity, at being noticed.* One kind gives the appearance at least of mental attention;† another utters sounds, in order to produce an assemblage of its kind;‡ and another, by its voice, announces to others its perception or apprehension of danger.§ To be deceived by a fraudulent imitation of its own calling sound, evinces correct sensation, and memory, and right judgment—but an error in reasoning, from not knowing the whole of the accompanying circumstances.‖

The FROG genus discover sagacities and feelings like those of other animals. When the young ones quit their native water, to join the older ones in the woods an meadows, they use every reasonable precaution.¶ The pearly frog of Brazil is distinguished for its beauty.** So is

caressed; appearing pleased at being turned over and over." La Cep. v. 2, p. 62. . . . The guana is taken by this sensitivity. As it basks in the beams of the sun, extended on the branch of a tree, the person who means to catch it, "advances slowly, whistling in a particular manner; the animal seems pleased with the sound, and extends its head as if to listen; coming nearer, and continuing to whistle, he tickles its sides and throat with a stick. It turns itself up gently to the action, and seems delighted with the treacherous caresses," but as it lifts up its head from the branch, a noose is slipped over its neck from the stick, and it is jerked to the ground. La Cep. 346.

* The pleasing basilisk, or little king, as it is called, from its crest, "as it shoots from branch to branch with great rapidity and adroitness, or in its state of rest, evinces a kind of satisfaction at being observed. Erecting its crown, it agitates its beautiful crest; alternately raises and depresses it head; and by various elegant movements, reflects various coloured light from its polished scales." La Cep. 367. . . . The green lizard also, "whenever it sees a man, seems to feel pleasure in displaying the brilliance of its eyes and its golden scales, as the peacock expands its plumage." Ib. 390. . . It plays with children; but when two are in confinement, they may be *excited* to fight. Ib.

† The strumous lizard "seems to examine every thing that comes in the way with attention; and has even the appearance of listening to what is said." La Cep. 2. p. 72.

‡ The supercilious lizard, l. superciliosa, so called from the projecting ridge over its eyes, is said by Seba, to cry very loud, as a signal for the scattered individuals to gather when endangered. Seba Mus. v. 1.

§ Seba mentions the forkheaded lizard as uttering a cry as a signal o danger. Ib. p. 109.

‖ The two spot lizard, l. cimaculata, is thus taken. Its voice is a kind of whistle, which it emits frequently. If a person carries towards it a bunch of straw, imitating its whistle, the animal leaps into it, and is secured. La Cep. 1. p. 330.

¶ "They begin their journey in the evening, travelling all night, on purpose to avoid becoming the prey of rapacious birds; always concealing themselves during the day under stones, or other recesses; and only resume their journey when night begins." La Cep. v. 2, p. 229.

** Its body is strewed all over with small grains or tubercles of a pale red colour, resembling pearls. La Cep. 246.

the common tree frog, which lives, like birds, on the branches of the forest, and in seeking insects is almost as light and nimble in its motions as they are; and is ingenious in its efforts for its successful provender.* The red tree frog is used, by the Indians of South America, to give a fine red or yellow colour to the feathers of their parroquets.† The most extraordinary property of frogs is that of being able to swallow fire.‡

The TOAD has been tamed and domesticated. One became familiar in a house for thirty-six years, and welcomed that light which, in its natural state, is offensive to it.§ It displayed here as much original mind as any other quadruped, and was never offensive.‖ This fact is sufficient to show that the living principle of the toad race has the same susceptibility, memory, will, perception, suitable judgment, and limited improvability, as every class of animated nature seems to exhibit.¶ The beavers have been

* La Cep. 257, 8. "Its contrivances for concealment, and for surprising its prey; the agility with which it springs for several feet among the smallest branches, and the facility with which it keeps itself safe from falling; are really admirable." p. 258.

† "For this purpose, they pluck off the feathers of the nestling ones, and rub the skin with the frog's blood. After this operation, the new feathers grow red or yellow, instead of being green as before." La Cep. 270.

‡ Catesby states that the land frog which inhabits Virginia and Carolina prefers those insects which shine in the dark. On a warm evening, a person in his company let fall some burning tobacco from his pipe, which was instantly swallowed by a land frog squatting close by. "Catesby offered it a little bit of lighted charcoal, which it swallowed immediately. He found, on repeated trials, that the land frog constantly swallowed whatever burning substances came within its reach." La Cep. 1. p. 233. Catesby's Carol. v. 2, p. 69, Lawson's Carol. 132.

§ "This toad had originally taken up its residence under an outer stone before the door of the house, and was of considerable size when first noticed. It came forth from its hole every evening, immediately on observing the candle, waiting deliberately to be lifted up and carried to a table within the house, where it was fed with insects, flies and millipeds. It particularly preferred maggots or small worms. It watched these with great eagerness, and, having measured the distance with its eyes, it darted out its long tongue, which brought back the animal to it." La Cep. p. 291, 2. Pennant's Brit. Zool. It lived 36 years thus domesticated, when a raven injured it at the mouth of its hole.

‖ "Having never been injured by any person, it showed no signs of uneasiness or anger when touched. Even ladies were curious to see it. After the raven had put out its eye, it could not seize its prey as before, "not being able to judge its distance and situation with the same accuracy." La Cep. 292.

¶ "We may perhaps conclude that when supplied with abundance of food of a particular kind, and when preserved from the ordinary dangers

proverbial for their intelligence, ever since North America, their chief seat, has become known; and the otters display the same maternal sensibilities which other orders of animals so strikingly exhibit.* The badger exhibits the domestic feeling of living with its mate, and is susceptible of tuition.†

Thus all quadrupeds seem to have been created to possess one analogous mind, uniform in its essential qualities but acting variously, according to the diversities of it bodily investments.‡

ncident to its natural life, *the toad may be improved*, like many othe species of animals." La Cep. p. 294.

* Our sea captains have observed on the N. W. coast of America, that when a female otter is attacked in company with her young one, she clasps it with her fore feet, and plunges beneath the surface; but, as the cub cannot remain long under water, she is forced to rise again very soon. If the hunters can come on the female by surprise, and separate her from her young one, the cub is taken immediately; but the mother no sooner *hears its cries*, than she swims to the boat from which they proceed, and, regardless of all danger, shares the fate of her little complaining captive. "It is a crafty animal, yet may be tamed, and employed to catch fish for its master." Kerr's Linn. 173.

† "The common badgers may be tamed, if caught young. It lives in pairs together, and is very cleanly." Kerr's Linn. 187.

‡ The vital principle in some animals seems to have a remarkable durability. Mr. Bingley has collected two cases, where the toad was found embedded within the wood of an elm and oak tree; and three where it was cut out of stone and marble; in each case alive or reviving into life. v. 3, p. 168. These instances appear authentic; but it is difficult to say which is the most extraordinary circumstance—that they should retain vitality in such an enclosure, or that they should have remained still or torpid long enough to have allowed the wood or stony matter to have formed around them.

LETTER XVI.

The serpent tribe—their peculiarities and mind—their more remarkable species—The alleged sea serpent.

THE SERPENT tribe exhibits the animal mind in another incorporation of material particles, approaching more nearly the lizard race than any of the preceding classes of animated nature; but yet distinguished from that, and from every other, by peculiarities appropriated to itself. It has sufficient similarities with all, to show that it is a part of the same general economy of animated nature: although identical with no other, it has analogies and relations to all It is one of the departments of the same grand empire of organized living forms and sentient beings; full of mingled beauty and terror; presenting to us a new exercise of the divine imagination in its system of creation; but more exclusively existing for its own enjoyment, and less serviceable to man or to the rest of nature, than any other animal genera that we have been reviewing.

The serpents have been arranged by La Cepede under eight genera;* each including subdivisions and many species;† of which the vipers are by far the most numerous.‡

Though destitute of feet and wings, few animals are so nimble as serpents, or can transport themselves from place to place with equal agility. Whether to seize its prey or escape from danger, the serpent moves with the rapidity of an arrow; and emulates, even surpasses, several species of birds in the ease and rapidity with which it gains the summits of the highest trees; twisting and untwisting its flexible body around their trunks and branches with such alacrity, that the sharpest eye scarcely follows its rapid

* These are,—the vipers, the boa, the rattlesnakes, snakes, the amphisbæna, cœcilia, langatra, and acrochord. La Cep. v. 3. . . . The genera of Linnæus, at first only six, are now made by his later editors the same, with a mere difference of position; as he puts the rattlesnake, crotalus, for the first, and coluber, the viper, as his third. Turt. Linn. 1, p. 639.

† La Cepede subdivides the vipers into two classes; one that produces the young completely formed, 27 species; the other, which emits eggs from which the young are afterwards hatched, in 169 species. v. 3, p. 175; v. 4, p. 1—187. . . . The Linnæan classification, without this specific distinction, enumerates successively 175 species. T. Linn. 674—95.

‡ To the boa genus, 11 species are allotted; 6 to the rattlesnakes; 24 to the snakes; 5 amphisbœnas; 2 cecilias; 1 langatra; and 1 acrochord. La Cep. v. 2, p 183—351.

motion.* Their size greatly varies: some are but a few inches long, while others extend to forty or even fifty feet. All are covered with scales, or scaly tubercles; and by this analogy are connected with the lizards and fishes. Their brain case is constructed, in some measure, like that of the oviparous quadrupeds; but not reaching so far back in them, scarcely defends the organ of the spinal marrow. Hence serpents are extremely vulnerable, and easily killed by blows, on that part of their head.† The rest of their skeleton has a strong resemblance to that of fishes; but from the nature of their respiration, they cannot remain long under water.‡

All parts of their body have great force, agility, and elasticity. They are most abundant in warm and temperate regions; but increase in size and numbers in proportion to the heat and moisture, and to the freedom of their range. They have less blood than quadrupeds, and a lower animal heat and less interior activity of system; and in these respects they come nearer to the formation of the insects and worms.§ They are more animated in times of tempest and hurricane, when the electricity of the atmosphere is in the greatest perturbation.‖ Their sense of hearing is dull, but their vision acute. Their eyes, for the most part, are excessively brilliant and animated, extremely moveable, considerably prominent, and advantageously placed for receiving the images of objects from an extensive field. They have a membrana nictitans to draw over their sight when the sun's rays are too powerful, or any injury approaches. Their sense of taste is probably of considerable delicacy, as the tongue is very slender, and divided into two points, which admit of its being readily applied to sapid bodies. They touch only by their plates or scales; but as they readily twist these round every substance, their sensations, from the contact, must be numerous, and their perceptions o touch proportionably nice and perfect.¶ They give many indications that their instincts and sensations have a superiority over those of all other animals, except birds and viviparous quadrupeds.**

* La Cep. v. 3, p. 2. † Ib. p. 6. ‡ Ib. p. 6—10.
§ La Cep. v. 3, p. 21—5. ‖ Ib. p. 26. ¶ Ib. p. 39—41.
** La Cep. p. 42. "They wait with amazing patience, almost absolutely motionless, and often for a very long time, the favourable moment for seizing their prey. They show very strong symptoms of violent rage when attacked; they erect themselves with great boldness against any one who stands in their way; they attack with vast courage, even enemies of superior strength; they throw themselves furiously against any

Several species of them live quietly about the habitations of mankind, and sometimes enter their houses and fix their residence there. They destroy troublesome animals and noxious insects which they find; but are so far from hurting human beings, that they often pass over their bodies and faces when asleep, without doing any injury. They wander about the rooms with great familiarity, and often seem to choose the finest bed for their repose.*

Serpents are so tamed as "even to show stronger signs of attachment to their masters than many kinds of domesticated birds, or even of quadrupeds, being only surpassed in fidelity by the dog."† Their length of life is unknown, and most likely differs in their various species.‡ They can exist so long without food, that it is probable, like the tortoise of Mr. White, whose eating season was the summer, they only seek it at particular periods.§

They have no voice, but a hiss, as their windpipe has no epiglottis to close its upper orifice, and thereby modify the extruded air into modulated sound. But this utterance is softer or stronger, according to circumstances; and is used whenever they are inclined to produce any sound.‖ It is therefore the voluntary effect and expression of the animal's emotions, feelings, and wishes; and from being spontaneously and forcibly issued when these occur, we may infer that it intends by that to signify its sensations. It is there-

person or animal that disturbs them in their combats or their attachments; and, on some occasions, the male defends his mate with the utmost violence." La Cep. 42.

* La Cep. 43.

† La Cep. 44. As to the fascinating power ascribed to the eyes of some of the serpent tribe, Dr. Barton, after having examined the subject, is of opinion that it does not exist; and that the reports of it have arisen from what has been noticed of the fears and cries of birds and other animals, when their nests and young seemed in danger. The alarmed bird watches the snake, and moves about it to prevent these from being discovered.

‡ Reasoning from their comparative growth, the Count La Cepede infers that the great serpents live as long as the crocodiles. p. 52.

§ M. Audubon had a rattlesnake in a cage which for three years refused all food. Bull. Univ. 1828, p. 369. Kalm found that this tribe "would live six months without food, refusing every kind of nourishment." Kalm's Trav. N. Am. It is said that a viper can live a year without any nourishment. "Mr. Pennant kept several in a box for several months without food, and yet they did not seem to have lost any part of their usual vivaciousness." La Cep. 230. . . . Dr. Shaw mentions that he saw at Venice two cerastes, or horned serpents, which had been kept in a large crystal vessel five years without any visible food. Travels Egypt, p. 411.

‖ "In the larger serpents, it appears only to indicate want, desire or rage. No peaceful sensation seems to actuate them in any sufficient degree for being expressed by their organs of voice." La Cep. 63.

fore meant by the serpent to be what words of passion, excitation, appetite, or desire are to us; for it is in these expressions of its mind that the varied sibilation is heard. Its milder sensibilities are not accompanied by any vocal annunciation. Yet perhaps if they were sufficiently studied, some light whispering or murmuring tones would be found to indicate their content or pleasure, since the hissing marks their excitement; as several animals of prey accompany their sense of comfort with the softer modifications of their vocal sound.*

Serpents have great strength, from the peculiar construction of their body.† They are so tenacious of life, that it is difficult to kill them by wounds in the body or by the exhaustion of air.‡ Severe cold only suspends the activity of their vital principle, without destroying it. The rattlesnake can bear to be thawed and frozen alternately, without extinguishing its life or functional powers.§ They have been, from all antiquity, and in most countries, celebrated for their great cunning or sagacity; which must be chiefly displayed in their modes of evading their enemies, or of obtaining the prey they seek for, when they desire it.‖— Some serpents are eminently beautiful, for their brilliant

* La Cepede makes the distinction, that "almost all animals of prey, as eagles, vultures, tigers, leopards, &c, only emit their cries when about to seize their prey, or to join in mortal combat; while most domestic animals and singing birds soften their voices into the expressions of peaceful joy, or tranquil and innocent pleasure." But Mr. Kerr adds to this a qualifying recollection, that "hawks, a species of eagle, and all the feline genus, have distinct expressions for peaceable satisfaction, for playfulness, and for caressing their young and their mates." p. 64.

† "This enormous strength in serpents is easily accounted for, from the immense number of powerful levers formed by their chine and ribs, acted upon by a body almost entirely composed of muscle, which winds all around the enemy they mean to destroy." La Cep. 67.

‡ After Redi and Boyle had apparently killed them by the total abstraction of air from the glass of an air-pump, they exhibited signs of life twenty-thee hours afterwards on re-admitting the fluid. One, taken near the fire, darted out its forked tongue, though it died the next day.

§ M. Audubon found a rattlesnake in winter as rigid as a stick, in a complete torpor, but, being placed in a bag on his back, he felt it move and took it off. It issued from the bag full of life, but the cold soon brought back its former state. He revived it several times by placing it near the fire. While it was torpid, all its organic functions ceased. He has often found them torpified, with much food in their stomachs frozen and not digested; but when he exposed the animal to heat, the digestion began again, and continued till the food disappeared. Bull. Univ. 1828, v. 3, p. 358, 9.

‖ Their food is according to their size and kind. Vipers take insects, beetles, scorpions, small lizards, young frogs and moles, small mice and toads. The great serpents lie in wait near waters, for goats and antelopes; and the great boa will attack and swallow even the tiger.

colours, of which several display fine iridescent changes.* It is a curious distinction of these animals, which has been lately made, that all the species of serpents of which the young are hatched within the mother, and which are therefore born alive, are venomous.† This seems to be more certain than the converse of the rule, that all oviparous serpents are not injurious.

But it has been ascertained that the oviparous serpents contain those species which are harmless and inoffensive. Even the oviparous vipers have no fangs, and possess no venom.‡ "They only offer to our consideration agile movements, elegant and light proportions, and soft or brilliant colours. The more we are familiarized to them, the more we shall be pleased to meet with them in our woods, our fields, and our gardens. They cannot disturb the pleasures of our rural habitations; but they may increase our enjoyments, by the beauty of their tints, and the vivacity of their motions. They are an addition to the ornaments of the fields; and help, with the other animated beings, to embellish the vast and magnificent theatre of vernal nature."§

The green and yellow viper may be seized without risk; and, after being taken, it becomes docile, and can in a great degree be domesticated and made amusive.‖ Though in

* The naja is admired for the splendour of its scales and the glow of its colours, but it is one of the most venomous serpents in the east; and "is supposed to have some distant resemblance to the human countenance in its head."—"Nature thus stamping the face of a most noxious reptile with a coarse image of the noblest of her works." La Cep. 274... It is the cobra di capello, the serpens coronatus of Ray. Synop. p. 330. This fancied resemblance arises from a stripe of a different colour from the rest of the body, "forming two circles round a pale part on the face, giving a faint likeness to two eyes, and, by a double curve, the rude representation of a nose; thus altogether having some likeness to the scratches of young attempters at drawing the human face." La C. 275.

† It was M. de la Borde, of Cayenne, who made this important observation. La Cep. 88.

‡ The green and yellow viper is of this sort. This species is as perfectly innocuous as the adder or common viper is noxious. Its colours are brighter and more lively, it is considerably larger, more elegant in its proportions, more active in its movements, and more gentle in its manners." La Cep. 339.... "Its eye is surrounded by a row of golden yellow scales." 340... "This beautiful viper usually grows to the length of three or four feet, of which the tail is about a fourth part." When of this size, two or three inches are its greatest diameter. Ib. 341.

§ La Cep. p. 337.

‖ "It may be taught to perform a number of evolutions by signal. We often see children tie vipers of this species by the tail, and make them creep along in any direction they choose. It allows itself to be twisted round the arms or neck, to be rolled up in a spiral, and turned about or hung up in any way, without showing any symptoms of anger or dislike. It seems even pleased to be thus teased and played with by its masters." p. 342.

its natural state it will, if interrupted, erect itself and hiss, either with anger or fear, yet it does no harm.* It has been known to exhibit attachment and affectionate feelings to its human friends.† The Roman or Esculapian viper is as mild and tractable.‡ The lady viper unites the same attractive temper with a superior beauty of form and colour.§ The boiga has a still more magnificent appearance,‖ with the same acquiescing gentleness,¶ and with an attemp at a musical intonation of the serpentine hiss.**

Of the other serpents, it need only be mentioned, her that the enormous boa twists itself round calves, and sheep

* La Cep. 343.

† Bomare mentions of a viper, what seems referable to this species: "It was so fond of a woman who kept and fed it, that it often rubbed along her arms, as if to caress her, and concealed itself among her clothes, or even in her bosom. It was obedient to her voice, came to her when called, followed her continually, seemed to know her laugh, and would turn to her as she walked, as if waiting her orders. On one occasion, Bomare saw her throw it into the water from a boat, as she was in one on a river; but obedient to her voice, it endeavoured to swim after her, till it perished in the waves." La C. 345. Bom. Dict. Hist. Nat.

‡ It is found in France, Spain and Italy. "It is as gentle and harmless as the green and yellow, the collared, the smooth, and the four-striped vipers; but perhaps more familiar in its manners. It allows itself to be caressed and handled by children. It likes to be near inhabited places, glides frequently into houses, and sometimes slips into the beds." It casts its skin. La Cep. 365, 6.

§ Coluber domicilla. Linn. "This is one of the gentlest and most beautiful of serpents. Its proportions are more elegant and delicate than in most others; its nimble yet moderate motions augment the pleasure produced by the beautiful mixture of its fine colours." La C. 377. . . . . "It seeks warm situations." "The smallness of its size, the beauty of its colours, the gentleness of its motions, and the innocence of its disposition, inspire the Indians with a fondness for it. Women take it in their hands, caress and cherish it. The ladies in Malabar place it in their bosoms, and it seems perfectly sensible of their kindness." La C. 379. . . . . The laced viper is as pretty, gentle and favoured. v. 4, p. 16.

‖ C. ahaetulla. "This species combines the richest colours of the finest gems, with the splendour of burnished gold mixed with the heightening contrast of dark brown shades. The scales of its head, and the whole upper surface of its body, are blue, changing its hue as it moves in the light; sometimes to an emerald green. This is finely variegated by a chain of golden yellow. The whole under-surface is of a silver white, separated from the back by a golden stream on each side, the length of the body. It seldom exceeds three feet in length, but is not an inch in diameter." La Cep. p. 39.

¶ "In the Isle of Borneo, the children play with it; carry it in their hands, and twirl it about their necks, arms and bodies. The boiga returns caress for caress to the Indian children, who fondle it; and seems pleased with their play." La. C. 42.

** "It conceals itself under trees, to surprise small birds, and is said to attract them by a peculiar kind of whistling." This, by a manifest exaggeration, has been called a song, in the description of Seba's Museum. La Cep. 41.

and goats, to crush their bones, and then swallows them whole, as common serpents absorb a toad.* It has been seen to overcome, kill, and devour tigers in this way, though not till after a desperate struggle.† The dangerous rattlesnakes are too well known to you to be described in this letter; but their pleasing sensibilities ought to be noticed;‡ and also the fact, that they do not willingly injure mankind.§ Nor will my space admit of any detail as to the genus of snakes, nor of the remaining classes. The facts which have been selected will serve to give you a sufficient general idea of this order of those diversified animated beings, which have been appointed to inhabit our highly variegated earth. In Egypt and Africa, serpent flesh has been made an article of human food;‖ and modern as well as ancient nations have made them objects of religious veneration.¶

* La Cep. 193, 5. For the most part it exceeds 20 feet in length. In Congo, they are 25; in the Molucca Islands, and in the Great Amazon river, from that size to 30 feet. 196, 7. . . The Mexicans worshipped it. 202. . . . It is also venerated in Mozambique and Japan. 205. . . . It has crushed and swallowed wild he goats, stags and buffaloes. 213, 214.

† An account of a struggle of this kind in India, was published in several periodicals, in a letter from a person who saw it and the tiger's fate. The boa, as with others, smeared his victim over with a slime, to facilitate the deglutition. One is affirmed to have thus swallowed a Buffalo. Bingl. 207.

‡ "Mr. St. John once saw a tamed rattlesnake as gentle as a reptile could be. It went to the water, and swam, whenever it pleased: and when the boys to whom it belonged, called it back, their summons was readily obeyed. They often stroked it with a soft brush; and the friction seemed to cause the most pleasing sensations; for it would turn on its back to enjoy it, as a cat does before a fire." Bingley, Animal Biog. v. 3, p. 203. Its fangs had been extracted.

§ "If not provoked, these animals are perfectly inoffensive to mankind, being so much alarmed at the sight of man, as always, if possible, to avoid them, and never themselves commencing an attack." Bingl. 203. Catesby remarks that they are never aggressors, except in what they prey upon. They have no inclination to bite, unless disturbed, and then give notice by shaking their rattles. Nat. Hist. Car.

‖ Dr. Th. Shaw says of Egypt, "I was informed that more than 40,000 persons in Cairo and in the neighbourhood, live upon no other food than lizards and serpents. This singularly entitles them to attend on the embroidered hanging of black silk, made every year for the Kaaba of Mecca." Trav. Barb. p. 412. . . . Lopez mentions that the negroes of Congo and Angola feast on the boa, "as they prefer its flesh even to poultry." Hist. Gen. Voy. 173, 249. . . . Carli mentions the same fact: "They feast upon its flesh, rejecting only the skin, tail, head and entrails." La Cep. 221. . . . Captain Stedmans mentions that the negroes wished to eat the boa he shot at, declaring its flesh to be exceedingly good and wholesome.

¶ The Gentoo Indians revere the fatal cobra di capello, as the Mexicans deified the boa. "They distinguished it by a name signifying emperor. All its motions were watched with great attention; and its long and violent hissings were heard with universal consternation. Some public

The serpent tribes with which we have become acquainted, are those which appear on land; whether the ocean contains any classes of this order of beings, is not yet admitted by modern naturalists. Pontoppidan, two centuries ago, described a formidable creature of this kind in the northern seas; but no late navigators having met with such a one, his account has fallen into discredit, though the American and other mariners have reported similar animals to have appeared occasionally on their coasts.*

calamity was expected to follow these warnings." Wood's Zoog. 2, p 88. Mr. Bryant has collected many notices of the serpent worship in antiquity, in his Analysis of Ancient Mythology.

* Several accounts having appeared, at various times, concerning a large SEA SERPENT seen in different seas, it may not be right to omit entirely to notice them. They are not of that kind which authorize the judgment to rest its scientific belief upon them, but they seem too many, and too unconnected with each other, to be wholly passed by. Future facts must be waited for, before we can conclusively admit that such an animal exists; but it may not be unuseful to notice a few of the more recent periodical statements: .... On 25 June 1827, about 45 miles from Cape Ann (Massachusetts Bay) one was said to be seen by Captain White, of the Hope, about 60 feet long, with 3 fins on its back. It came within 25 feet. Salem Gazette. .... Five witnesses deposed that one appeared off Norway, on 24 August 1827, of a dark colour. Its head and about twelve feet were out of water. It swam away in several bends, which had intervals of 40 feet. From these it was calculated that the whole animal was above 400 feet, and as thick as a hogshead. On the 26th August, it was seen 260 fathoms off. On September 3d again at New Handspike. On 5th, off Lysagen. Christian Lett. New Times, 18 Sept. 1827. This is the most extravagant account of any recent ones, and reminds us of Pontoppidan's wonders. .... Don Lopez, Captain of a Havana steamer, reported to the Captain General of that place, that, on 3 Jan. 1830, at 4 miles from the coast, he saw the upper jaw of a great fish rise about 16 feet above the surface of the water, with others of various sizes playing about it. About 60 feet from its mouth was a great fin or wing 9 feet high: its tail remained under water. It suddenly sank, but rose, ten minutes after, farther north. It was larger than a whale, and of a different size. Charlstown Courier. .... In February 1830, a sea serpent was seen off the Isle of Lewis, in the Hebrides, for a fortnight, sporting in the arm of the sea called the Broad Bay. It was from 60 to 80 feet long, of a white colour, with a mane. Inverness Courier, March 1830. .... Captain Hancock described one, as seen by him in April 1830, off St. Augustine's Bar, near Florida. His length from 20 to 25 feet; his jaws wide enough to receive a small barrel, with 4 rows of teeth; his head like an alligator's; his fins 4 to 6 feet long, like a seal's, and of the size of a common door; the tip of his tail sharp, like a harpoon. Leaping forward to catch a porpoise, he sprang 5 or 6 feet out of the water. Savannah Georgian, Ap. 23. .... The New-York Gazette of 2 Sept. 1831, stated, that a sea serpent was seen, the second time this summer, off Boar's Head, Hampton Beach, on the preceding Saturday, and was carefully observed by several persons for fifteen minutes... Such are some of the latest accounts, which seem to relate to different animals of the serpent form; but the describers and the descriptions are not such as the cautious naturalist would deem satisfactory authorities.

LETTER XVII.

On the formation of insects—Their classes and importance—Their metamorphoses—Their actions and habits—Their senses, qualities, mind, and feelings.

THE INSECTS and WORMS were the "creeping things which were ordered to appear among the creations o the sixth day. As they have recently become objects o much attention, and have been described in their most striking characteristics, with great knowledge and discrimination, by very able naturalists, our countrymen and contemporaries, it will fulfil my purpose of laying before you a general map of created nature, if I select only a few facts and observations which will bring some of their most remarkable properties and peculiarities under your consideration.

The insect race are, in number, by far the most considerable portion of animated beings; and whoever duly studies their habits, economy, and uses, "will acknowledge that they have been created with design; and will not doubt but the design was benevolent."*

The triple metamorphosis or transformation which most of them undergo, has been said to be effected by casting off the different coats or coverings in which the perfect insect is inclosed; but it may be more near the unknown truth to say, that the perfect insect is forming or developing in the first or caterpillar state, and is completed in its second or chrysalis condition, from which it emerges into a new and more active existence, which is its last and reproducing form.†

* Samouelle's Entomologist's Companion, p. 17. "All genuine insects have six legs; a head distinct from their body, furnished with two antennæ; and pores for respiration, conducting to tracheæ, arranged along their sides. They are all produced from eggs. Some undergo no metamorphosis; others but a partial change; whilst the remainder pass through three stages of existence, after their egg state." Ib. 21.

† "The egg is first excluded by the female, and contains the insect in its smallest state. From the egg is produced the larva, grub, or caterpillar, of a moist, soft substance, without wings, slow in motion; often with numerous feet; sometimes with none; sterile; and very voracious of its proper food. From this state it passes into that of the pupa chrysalis, or nymph; which is drier and harder than the last, confined in a narrow compass; naked, or inclosed in a web; often without a mouth; and sometimes with, sometimes without feet. Escaping from this last

Linnæus arranged them into seven orders; and these into many genera; which were again subdivided into a large multiplicity of species.* The real quantity of these we may conceive, when we find that three thousand of them are to be found in Great Britain alone. The multitude must therefore be very great, which are existing elsewhere.† It is not necessary to say that they are the favourite productions of the Creator, because each of his kingdoms claim and deserve the same idea: all his works on earth have bee favourite operations with him; though most of all, our muc honoured and most favoured race. The flower and th fish have been as finely imagined and as elaborately executed as the richest butterfly and the most brilliant beetle. But we may admit, that He has combined and displayed in the insect world the beautiful and the graceful, the interesting and the alluring, the curious and the singular. They deserve our notice, and compel our admiration, not only for their sprightliness, forms, and colours, but also for (what most impresses my mind) exhibiting to us another investiture and display of the living, and sentient, and thinking principle; and this, in full activity and power within figures and limbs so small, as to compel our wonder at the nature of that intellectual mystery and miracle to which space is indifferent, and which is equally efficient and astonishing in the smallest as in the greatest body—in the winged fly, that is but a speck, as much as in the elephant, the boa, or the eagle.‡ The mental principle is shown by the insect

confinement, it becomes the perfect, active insect, furnished with antennæ." Turt. Linnæus, v. 2, p. 4.

* These orders, in his own last edition of his Systema, were, Coleoptera; Hemoptera; Lepidoptera; Neuroptera; Hymenoptera; Diptera; Aptera. T. Linn. 4. . . . . Fabricius endeavoured to supersede this system by a different one, in thirteen classes; but it has not been found so useful as the Linnæan.

† "These, in Britain, are probably not one-half of the European insects while we know that every other quarter of the globe is still more prolific in species wholly different. Every kind of plant probably affords nutriment on the average, to three or four species of insects. Hence there can be little doubt that the insect is vastly more populous than the vegetable world." Sam. p. 46. . . . . This estimation is moderate; but Mr. Kirby states the British insects to be 10,000; and that the number in the whole globe may amount to 400,000 species. v. 4, p. 477. But these vast calculations are too vague to be relied on.

‡ A yellow insect is now running before me, not bigger than a dot, but as rapid, for him, as a dog in full speed. He runs straight forward over my paper, and turns toward the inky letters. What are dry, he runs over; what he finds wet, he s[illegible]et, and goes round them; he runs over

world to be quite independent of magnitude or matter; of general form, and of any particular organization. It is energetic, effective, and manifest in all. It is equally associable with every combination of material element; although it never appears but in assigned, regular, transmitted, and specific configurations. It is every where in diversified, but in special organizations, reproducible only from themselves. Insects, notwithstanding their multifarious nature, demonstrate this truth as clearly as the plant or the quadruped. No insect produces any other species than its own; but each class steadily continues its descending perpetuity. Yet still their external appearances are so curious and pleasing, as to deserve our attention; and often our warmest admiration.*

The metamorphoses of insects are their most characterizing peculiarity. In these we certainly behold three distinct animals, as dissimilar from each other, in some genera, as the bird is from the serpent and the shell-fish; and yet united into one and the same living being, by the personal identity of their principle of life. This only continues permanent and abiding through their triple change of material form. The bodily substance undergoes the most striking mutations; but the existing and feeling self remains unceasing and unaltered through all. The same animal crawls in its caterpillar shape; rests or sleeps in its torpid chrysalis; and springs from earth into air, with its new wings, its proboscis, and its antennæ, in its butterfly or moth configura-

the white space in a direct line for some time, either obliquely, straight, or in a horizontal one. When I put the feather of my pen in its way, it stops, and remains for some time motionless, till, finding no further alarm, it resumes its activity. It certainly paused by its own choice and will. It exerted an act of judgment as it came to the ink; it deemed, or felt that o he unsuitable, and repeatedly turned from it; yet it discerned when it was dry, and then ran over what became so. In the space of a small dot, printer's full stop, it had moveable legs and their muscles, and displayed ll the activity, power, and thought of a larger animal.

* We may coincide with Mr. Kirby and Mr. Spence, that to these "valued miniatures" nature, that is, its author, "has given the most delicate touch and highest finish of her pencil. Numbers are armed with a glittering mail, like burnished gold, the genera eumolpus; in others, is the dazzling radiance of polished gems. Some are decked with what looks like liquid drops or plates of gold and silver. Some exhibit a rude exterior, like stones in their native state, the genus trox; while others represent their shining state from the tool of the polisher. Some vie with flowers in the delicacy and variety of their colours; others in the texture of their wings; and others in the rich cottony down that clothes them." Kirby and Spence Entom. v. 1, p. 8.

tion. What a stupendous wonder this magical transformation would be to us, if it were not so familiar.* There is no reason to doubt that all the parts of the butterfly are in the caterpillar; as those of the human being are in the oval embryo. The material mechanism, the specific organization, is all ready and arranged; though not at first discernible, from its invisible minuteness.† Gradually, this hidden form increases into an object of sight; every limb and function enlarging in just and progressive proportion; until the complete figure, so exactly beforehand conceived, assigned, and provided, grows into its last perfection, and emerges like a new creation, into its aerial and beautiful vivacity.‡

It seems like a resurrection from the tomb into a fresh life, with celestial destinations. It is so analagous to that which the human spirit is appointed to undergo, that the intellect cannot well avoid viewing the insect transformation as the emblem, the token, the natural herald and promise of our own. The ancients, without our Christian Revelation, thought so; for, one of their most pleasing imaginations, yet visible on some of their gravestones which we dig up, is that of a butterfly over the name or the inscription which they record. They place the insect there as the representation of their Psyche—of the ani-

* "That butterfly, at its first exclusion from the egg, and for some months of its existence afterwards, was a worm-like caterpillar, crawling upon sixteen short legs, greedily devouring leaves with two jaws, and seeing by means of twelve eyes, so minute, as to be nearly imperceptible without the aid of a microscope. You now view it furnished with wings, capable of rapid and extensive flights. Of its sixteen feet, ten have disappeared; and the remaining six are in most respects wholly unlike those to which they have succeeded. Its jaws have vanished and are replaced by a curled-up proboscis, suited only for sipping liquid sweets. The form of its head is entirely changed; two long horns project from its upper surface; and instead of twelve invisible eyes, you behold two very large ones, *and composed of at least* 20,000 *convex lenses*, each supposed to be a distinct and effective eye." Kirby, Sp. p. 61.

† "A caterpillar is not a simple, but a compound animal, containing within itself the germ of the future butterfly." Ib. 71.

‡ "In the internal conformation, you witness changes even more extraordinary. In the former, you would find some thousands of muscles, which in the latter are replaced by others of a form and structure entirely different. Nearly the whole body of the caterpillar is occupied by a capacious stomach. This has become converted in the butterfly into an almost imperceptible thread-like viscous, and the abdomen is now filled by two large packets of eggs or other organs, not visible in their first state." Kirby and Sp. 62.

mating and surviving soul; as the intimation that it will re-appear in a new form and region of being.* It is thus analogous to the word "resurgam" on our hatchments. It beautifully and picturesquely declares, "Non omnis moriar—I shall not wholly die; but I hope yet to rise again." The allusion and the applicability are so striking, that I cannot but believe that one of the great purposes of the Deity in creating his insect kingdom was to excite this sentiment in the human heart; and to raise by it the contemplative mind to look forward to a possible revival from the tomb, as the butterfly from its sepulchral chrysalis.† Like the insect, the human personality has three states, and changes, and forms of being, but continues indestructible through all. It emerges from its ovum into the figure and life of the present fleshy body; it rests in its earthly grave, unextinguished, though visible to mortal eye no longer; and it will emerge from that at the appointed time into its ethereal nature and immortalized capacities; always the same self in each transmutation; never dying or dissolving with its material investment; but surviving, to bloom in everlasting youth amid the most exquisite felicity—the spiritualized butterfly, with angel wings perhaps, and an imperishable vitality.‡

The fly passes through such changes to its winged state.§ So does the knat, that annoys us, though always peculiarly alert in its own happiness.‖ The beetle likewise.¶ And such a transformation the little maggot, that we meet with in the nuts we open, undergoes if undis-

* It is also on some of their gems, with the same metaphorical allusion.

† This "intermediate state is not less singular. After casting its skin, to its very jaws, several times, and attaining its full growth, the caterpillar attached itself to a leaf by a silken girth. Its body is greatly contracted; its skin once more split asunder, disclosing an oviform mass without exterior mouth, eyes or limbs, and exhibiting no other symptom of life, than a slight motion when touched. In this death-like torpor, and without tasting food, the insect exists for several months." K. Sp. 62.

‡ The Italian poet quoted by Mr. Kirby, expresses the same impression:—

——— noi siam vermi,
Nati a formar l'angelica forfalla?

§ "This was the other day but a disgusting grub, without wings, legs, or eyes." K. Sp. 63.

‖ The gnat "was, a few hours ago, the inhabitant of a stagnant pool, more in shape like a fish than an insect, breathing through its tail." Ib.

¶ The beetle passes her first period as a grub, under the surface of the earth. Ib. 64.

turbed.* These successive states of insects, after the egg, are usually called the larva, the pupa, and the imago. Most, in the second, the pupa or chrysalis stage, never eat; but several species continue to move and feed.†

On the direct and indirect benefits derived by mankind from insects, and on the injuries which occasionally arise from them, you will find a copious statement in the valuable work of Mr. Kirby and Mr. Spence.‡ Their chapter on the food which these little animals seek and draw from both the vegetable and animal kingdoms, will also inform and interest you.§ For ample details on their several states, and on their external and internal anatomy, I would also refer you to the facts and observations which they have collected and suggested.‖ Much important and curious information is contained in their section on the geographical distribution of insects—the stations and haunts, seasons, times of action and repose.¶ No brief view would do justice to these topics; nor to that which displays, above all others, the nature and activity of the insect mind—I mean the formations of their peculiar habitations.** On this gratifying theme, Mr. Rennie's elaborate inquiries and minute descriptions will be also found peculiarly interesting.†† Indeed, all his publications on insects, in the Library of Entertaining Knowledge, present to us a well selected compendium of the latest and most authenticated information, with many judicious and original remarks on this hitherto too much neglected department of animal nature.‡‡

* "This shapeless maggot, having gnawed itself an opening, entered the earth and passed there a few months in a state of inaction, would at length emerge into an elegant beetle, with a slender and long ebony beak, six feet, two wings, and two wing-cases ornamented with yellow bands." K. Sp. 64.

† As the tribe of locusts, cock-roaches, bugs, spiders, &c. K. Sp. 68.

‡ See Letters 9 and 10, vol. 1, p. 299 and 249; and the four Letters, p. 1—248.

§ Letter 12. p. 382.

‖ On the egg state, v. 3, p. 52; on the larva, p. 105; on the pupa, p. 238; on the imago, p. 291; on the external anatomy, p. 348—720; and on the internal anatomy, v. 4, p. 1—196.

¶ Letter 49. v. 4, p. 474.

** Letters 14 & 15. vol. 1, p. 434—517.

†† These are comprised in one volume, in two parts, on insect architecture; containing, in a moderate compass, the most complete collection of facts, illustrated by useful plates, on this branch of insect history, that I have met with.

‡‡ His volume on insect transformations, contains five chapters on the eggs; five on the larvæ: three on the pupæ; and four on the perfect

Other scientific men are also now elucidating it, both at home and abroad. The British intellect is cultivating useful knowledge in every field of human inquiry.*

The actions and habits of the insect world display the same kind of animal mind and feeling which the birds and quadrupeds exhibit. If there be a difference, it is not to the disadvantage of the insects; for the ants, and bees, and wasps, and especially the smallest of these, the ants, o things, and exercise sensibilities, and combine for pur- oses, and achieve ends, that bring them nearer to man- ind than any other class of animated nature. As much maternal care in depositing their eggs as fishes and oviparous quadrupeds exert, many insects show. The white butterfly roves till she finds the proper cabbage plant, in which she may lay her burthen most fitly for its welfare.† The dragon-fly seeks the water, as the most proper for her brood;‡ and the gad-fly so places her eggs, which are to be nourished in the entrails of animals, as to be on the

insects, their motions, locomotions and rests. His "Insect Miscellanies" treat on their senses, food, social and domestic habits, pairing, migrations, government and wars, and on their preservation and systematic arrangement, all rich in well chosen circumstances, intelligibly narrated, with copious explanatory plates.

* I see with pleasure some new works advertised in England, on this department of nature. In France, the "Iconographie et Histoire Naturelle des Coleopteres d'Europe," by Le Comte Dejean and M. J. A. Boisduval, now publishing in parts, promises to be one of the most complete works on this class of the insect world. The study of this miniature order of beings requires great patience and persevering attention; but the pursuit of every branch of knowledge repays the trouble, by the mental gratification which always accompanies it. Thirty thousand bees were examined before Huber's work on them was completed; but the labour was an enjoyment. So is every employment of the mind, in what he likes, to the humblest artisan; and mind is exercised in every thing that e fabricates well. The skilful mechanic exerts his intellect as much as he philosopher. Their subjects vary, but the process of thought is similar. The operative is sometimes as imaginative as the poet. Intellect and industry are never incompatible. There is more wisdom, and will be more benefit, in combining them, than scholars like to believe, or than the common world imagine. Life has time enough for both, and its happiness will be increased by the union.

† Kirby and Sp. 1, 339. "Her own food has been honey drawn from the nectary of a flower; but, as if aware that this food would be poison to her young, she is in search of some plant of the cabbage tribe. She recognises the desired plant the moment she approaches it, and upon this she places her precious burthen, yet not without the further precaution of ascertaining that it is not preoccupied by the eggs of some other butterfly." Ib. 340.

‡ Ib. 340.

spot from which their tongue will absorb them and convey them into its stomach.* The earwig, like the fowl, sits and hatches its young; a remarkable analogy of maternal instinct.† The field bug seems also to vindicate the feelings of a mother;‡ and one species of spiders gives manifestations of a resembling care.§

That the mason wasp, when she deposits her eggs, should also seek and place in the same hole enough grubs to be the food of her young ones when they leave their oval

* "She places her eggs on those parts of the skin only which the hors is able to reach with his tongue; nay, she confines them almost exclusively to the knee or shoulder, which he is sure to lick!" Kirb. 341. The larva is vivified from the egg within him, and having ceased feeding, are passed from his body. Mr. Clark thinks that the good which our cattle derive from them is, that they act as useful stimuli or blisters. Ib. 148.

† "She absolutely sits upon her eggs, as if to hatch them, and guards them with the greatest care." Frisch first noticed this. De Geer having found an earwig thus occupied, scattered the eggs in all directions; she soon collected them one by one into a heap, and assiduously sat upon them as before. When born, they "creep, like a brood of chickens, under the mother's belly, who will often, as De Geer found, sit over them in this posture for some hours." Kirb. 352. De Geer, v. 3, p. 548.

‡ The cymex griseus. It inhabits the birch tree. "The family of this field bug consists of thirty or forty young ones, which she conducts as a hen does her chickens. She never leaves them; and as soon as she begins to move, all the little ones closely follow, and, whenever she stops, assemble in a cluster round her. De Geer having cut a branch of birch, with one of these families, the mother showed every symptom of uneasiness; instead of immediate flight, she never stirred from her young, but kept beating her wings incessantly with a very rapid motion, evidently for the purpose of protecting them from danger." Kirb. 359. De Geer, v. 3, p. 262.

§ The aranea saccata, common under clods of earth. It has a white silken bag attached to the end of her body, in which she has deposited her eggs. "No miser clung to his treasure with more solicitude than the spider to her bag. She carries it with her every where. If you deprive her of it, she makes the most strenuous efforts for its recovery. If you restore it, her actions demonstrate her joy. She seizes it, and, with the utmost agility, runs off with it to a place of security. Bonnet, to put her affection to the test, threw her into the hole of a large ant-lion, in the sand. He seized her bag; she struggled till it loosened from her tail; she then regained it with her jaws, but his superior strength pulled it into his sand, and she chose to be dragged in with it, rather than to forsake it. Bonnet forced her from it, but she would not leave the spot, though repeatedly pulled away. . . . . When the proper time comes, she makes an opening in the bag for the young to come forth; they run in clusters upon her back and legs. She carries them about with her, and feeds them till able to help themselves." Kirby, 361. . . . Bonnet, 2. p. 425. . . De Geer, 7. p. 194. . . . Many other species of the same tribe show a similar attachment. K. 362.

shell,* announces parental foresight and provision which no fish or oviparous animal has been found to equal. But that another kind of the same wasp should not only add this supply, but also about the time when the new brood would be in life, and have consumed it, should open their cell, and put into it another grub for their nutrition, and should repeat this till they are fit to find their own provender;† and that others should, in the like manner, provide a succession of flies for their offspring while unable to help themselves;‡ are circumstances which compel us to admit that insects have maternal instincts as completely as the hen, the cat, the lioness, or the bear. Beetles evince also parental care for the sustenance of their emerging brood, and exert great labour to provide it.§ But the ants,‖ the wasps,¶ and the bees,** in different modes, yet with equal clearness, establish their claim also to the possession of these interesting sensibilities. Here also diminutiveness makes no disparity. The mother is as complete in the pettiest as in the largest—in the ant as in the whale.

Thus, insect mind and sensitivity appear, from the similitude of these phenomena, to be but the common animal mind and sensitivity in an insect form of body; in miniature configurations of material particles, peculiarly and variously arranged.

Insects have the senses of other animals, though varying in their modifications and acuteness.†† Their hearing has

* "It places along with its eggs about twelve little green grubs, without feet, if small; but only eight or nine, when larger." Kirb. 347.

† Kirb. 357... Bonnet, 9. p. 398. So the ammophila vulgaris of Rolander.

‡ As the yellowish wasp of Pennsylvania, described by Bartram in Phil. Trans. 53. p. 37; and duhamel sphix, mentioned in Reaum. vol. 6. p. 269.

§ M. Gleditsch, in 1752, had placed a dead mole on a garden bed, and on the third morning after missed it. Digging below, he found it three inches under the surface, and four beetles (necrophorus vespillo) under it. These had dragged it down as food for their young, for, three days afterwards, he found it swarming with their larvæ. To be sure of the fact, he put four beetles in a glass vessel half filled with earth, and on this two dead frogs. In twelve hours they buried one, and the other by the third day. So a dead linnet and other animals. In 50 days, the four beetles interred 4 frogs, 3 small birds, 2 fishes, 1 mole, and 2 grasshoppers, manifestly for their young, as one mole would have served themselves a long time. Kirb. 351—3... Gleditsch, Phys. Bot. 3. p. 200—27.

‖ On these, see Kirby, 364—7.

¶ Kirby, 372.

** Ib. 375.

†† "That they can see, touch, taste and smell, no one denies. Linnæus

been questioned; but it seems certain that some, at least, possess this faculty.* A nervous system, analogous in matter and offices to the same substance wherever it exists, but in several respects differently organized and distributed, has been traced in their bodies.† The exact uses of their antennæ have not yet been satisfactorily or fully ascertained.‡ One of their most extraordinary properties is that which some species display, of producing or extricating light within their own bodies, from their functional actions. The glow-worm is a familiar instance of this. The brilliance it emits appears to have the usual qualities of common light, even to the effect of heat.§ Such phenomena cannot be a creation of the luminous fluid; and therefore must be an emission of it, by decombining it from some of its combinations. This fact is a confirma-

and Bonnet thought them deprived of hearing; but numerous observations prove the contrary.

* "Upon my making a slight but distinct noise, the antennæ of an apion started. I repeated the noise several times, and invariably with the same effect. So an harpalus. Flies move all their legs at brisk and distinct sounds; and spiders will then quit their prey, and retreat to their hiding places." Kirby, 230. . . . Brunelli kept several males of the grasshopper, acrida viridissima, in a closet, which were very merry, but a rap at the door would stop them instantly. By practice, he learned to imitate their chirping: when he did this at the door, at first a few would answer him in a low note; and then, the whole party would sing with all their might. Ib. Lehman's de Sens. Ext. 22.

† "The nervous system of insects consists of the brain, the spinal marrow, and its ganglions and the nerves." Kirb. 7. . . . Linnæus denied the brain; but there is a part which Virey thinks to be analogous to it, and Cuvier and Lamarck so name it. Ib. 8. . . . "The nerves of insects, as of other animals, are white filaments running from the brain." In one caterpillar, Lyonnet counted 92 nerves; whereas in the human body, anatomists reckon only 78. Kirb. y. 4. p. 14. . . . Lyonnet, p. 192.

‡ Mr. Kirby thinks their primary function to be analogous to hearing,—as a secondary, to explore by touch; which all admit; but not of smell, which is a subject of much controversy. 239—255.

§ Each sex is luminous, but the female most brilliant, and larger, and has no wings. They always become much more lucid when in motion, and can withdraw the light when they please. Very little is seen when they are at rest. Mr. Temple, who studied them, never saw a glow-worm exhibit its lustre at all, without some sensible motion either in its body or legs. When the light was most brilliant, he fancied that it emitted a sensible heat. When a glow-worm is put into a phial, and that is immersed in water, a very beautiful irradiation takes place. If the insect be crushed, and the hands or face be rubbed with it, they contract a luminous appearance, like that produced by phosphorus. It arises in the insect from two points on each of the two last rings of the abdomen. They are chiefly to be seen in the month of June. Bingl. v. 4. 33. . . Latreille, Hist. Nat. des Insectes.

tion of our previous intimations, that light enters into the composition of material things; remains there, like heat, in a latent state; and is extricable from them by appropriate agencies. In this case, the animal will or action has the power of decomposing it.*

Insects, as to their habits and occupations, are divisible into two classes—those which lead a separate individual life, without any particular associations with each other; and those which are born and live wholly in regular societies. The latter display the most striking features of intellectual powers; but the most inconsiderable and secluded evince continual indications, that no one is without its share of that degree and kind of mind which all animated nature is found to possess.† Very few have been much studied; and it requires such a long, and persevering, and patient attention, to perceive and to understand their habits, and their meaning and ends in what they do, and to trace from these their ideas or feelings, that the intellectual principle of the insect world is very little understood. If it were more accurately known, it would perhaps be found to be only one branch of the same general mind which all animals possess. I am strongly inclined to believe that all animal mind is in its essential principles alike in every one, but varied in its external indications by the peculiarities of its bodily frame.

That insects have spontaneous self-motion and free agency we continually see. They fly about as they please. They are not in a mechanical body, like a wooden or

* "Dr. Todd has made some curious observations on the luminous power of the lampyrides. His inferences are,—

"Their emission of *light* is purely a vital action. It shows a new power of animal life—the power of *separating light* from its combinations with matter. This resembles the phenomena of animal heat. Animal light is an action of organic life. The male glow-worm seems oid of it; but the least irritation causes the instantaneous appearance of t. Even the ova of these insects emit a form of light. Their power of hining depends much on their vigour. It is confined to certain parts of heir body. It resides in a peculiar adhesive matter like animal gluten, dhering to the abdominal rings. It is *not* extinguished in vacuo, nor under mercury, water, or oil." Journ. Sci. No. 42. p. 244.

† "The history of insects that live in solitude, consists of their generation, their peculiar habits, the metamorphoses they undergo; their manner of life, under each successive form; the stratagems for the attacks of their enemies; and the skill with which they construct their habitations. But that of insects which form numerous societies, offers new relations which arise from common interest; from the equality or superiority of rank, and from the part which each member supports in the society." Kirby and Sp. v. 2. p. 30.

metallic automaton, made by human art, which has a certain number of springs that move its arm into as many determinate movements as these are provided to occasion, and no other. No fly comes in one straight undeviating, or in one fixed circular line, compelled to move only in that, and so to return; but we see that it can and does move in all directions, from its own spontaneous impulses, and in all degrees of quickness or slowness; and comes and goes as it pleases. Every butterfly, gnat, or beetle, does the same No man has or exerts a more manifest, free, and self-originating agency, ever diversified, changeable, and uncon strained, than all winged insects display, wherever we see them.

We equally see the full and free exercise of individual choice and will. Try with any walking insect; it will move, not as you choose, but as it likes. Check it in one path, and, unless through fear it pauses, it will take another. It will not go in the course or to the point you wish, if left to itself, or without a positive compulsion. I have often tried and watched them, and have been satisfied, that as far as concerns themselves, and all constraining force withheld, they have as much free agency, spontaneous motion, and freedom of will, as I have; and use these qualities as independently and with as much self-choice and determination as I do so. There is nothing like over-ruling, confining, and automatical agency or compulsion about them. Their motions exhibit continual changes of will and self-choosing action.

They show me, that they have as clear and just a perception of external things as I have. The fly knows the treacle; the wasp, the sugar; the bee, his hive and honey; the caterpiller, the herb he likes, as well as I do. If driven away, they return to the thing they desire. The bee does not go to a leaf, instead of the flower; nor to a stone, instead of a tree. They perceive what they want to be the thing they want or like, and they move towards it accordingly. In this conduct they judge as rightly about it as I should do, and act as congruously towards it. The more we study the actions of insects with reference to their nature and purposes, we shall find that they habitually act with as much proper judgment concerning them, as our mind in their bodies would do. As far as I have observed and can anticipate, they act as I should act if I were in their frames, and had their wants and wishes, and were under the same

circumstances and situation. If we were ants, or bees, what could we do better than what they do?* The instances, of wasps and others reducing the weight or shape of their prey, to enable them to carry it, are instances of both reasoning and judgment.† So is that of the beetles undermining the stake, to get at the toad, which it held above their reach.‡ So is that of the humblebees piercing the side of the calyx, to get at the honey when they cannot reach the nectarium by going within it.§ No human parent could exert more reasoning and affectionate foresight for the benefit of the child that was about to be born, than another species of bee uniformly displays.‖ The earwig appears to hatch her eggs with the maternal assiduity of the hen, and to allow no opposing interposition to frustrate her intention.¶ To assist a fellow creature with the cooperation of

* "I saw an ant one afternoon drawing out of her nest under a grass-plot, a small straw with her mouth. She came up backwards. When on the level ground, she turned, and holding it in her mouth, pushed it before her. When the short grass hindered or stopped it, she turned quickly round, and went through the obstacle backward with it, till she had got through the difficulty, then turned round to go forward, as before. When another bunch checked it, she turned again, and went backward through the obstruction. It was all done with correct and instantaneous judgment. I plucked some of the grass near their nest, and at least thirty rushed out, running all about, as if to see what had occurred, or was causing the unusual concussion. Finding no further alarm, they returned quietly to their home.

† Dr. Dawson relates, that he saw a wasp with a fly nearly as large as himself. Having separated the tail and head from the body, it rose with this in its paws, but a breeze catching the fly's wing, turned them round. The wasp then descended to the gravel, and cut off with his mouth the two obstructing wings, and then flew off easily with the body. Zoonomia, v. 1, p. 263. 3d ed. . . . . Reaumur describes a sphix cutting away the legs and elytra of a cockroach that was too big for its hole. v. 6, p. 283. Kirb. 2, p. 521.

‡ To counteract the burying beetle's operations, a dead toad was fixed on the top of a stick. It was found that, unable to reach the animal as it was placed, they dug below the stick, to make that fall down, and then buried both, in order to secure the load. Gleditsch Phys. Bot. 3. p. 220. Kirby, v. 2, p. 522.

§ Huber mentions this fact in Linn. Trans. v. 6. Kirb. 522.

‖ The "Apis Willughbiella," first discovered by Dr. L. King, and further elucidated by Mr. Willughby. "The parent bee forms long cells in the wood of old willows, in the direction of the grain of the wood, and in these deposits her eggs. She envelopes each egg in pieces of rose leaves, rolled up like a cartridge, placing in it a quantity of food, sufficient to support the young animal while in the state of a maggot. This remains till it has undergone its transformation, and then comes out a full-grown bee. Phil. Trans. v. 5, p. 2093. Thoms. Hist. R. Soc. 90.

¶ In the month of June, M. Geer found, under a stone a female earwig accompanied by many little insects, which appeared to be her own

our labour, when it is needed, is an act both of an observing and meaning mind, and of a benevolent feeling; and such an operation is performed by the pillchafers.* It is a curious instance of the analogy which the creation has spread through all her races of animal being, as if to manifest that one Maker's mind and agency have fabricated all things, that some insects appear to have the faculty and habit of the nutritive rumination.† Their discernment of the best place to be in for their transformation from their caterpillar state, and intentional motion on purpose to put themselves in it, has all the semblance of perceiving and judging mind.‡ It is not resolvable into mere external impulse. It seems to arise from the animal's own will and determination on its sensations and necessities.§

young. They continued close to her, and often placed themselves under her belly, as chickens do under a hen. At another time, about April, he found a female earwig under some stones, placed over a heap of eggs, of which she took great care; never forsaking them. He placed them in a box half filled with earth, and dispersed the eggs up and down in it; but she soon carried them, in her jaws, one after another, into one place, and remained constantly on the heap without quitting it for a *moment*, as if sitting to hatch them. In the middle of May the young ones appeared Bingl. Ann. Biog. v. 4, p. 42. . . . . Earwigs are harmless to all things but fruits and vegetables, in their season. Ib. 43.

* They form a pellet of dung as a nest for their young, and roll these to the hole they have made for them. They force the ball along with their hind feet. Catesby frequently saw them assisting each other, by two or three joining to trundle the ball, which a single one could not manage. Catesb. Carol. Bingl. 4, p. 11.

† Gilbert White remarks of the mole cricket, "anatomists who have examined the intestines of these insects, say, that from the structure, position, and number of their stomachs, there seems to be a good reason to suppose that this and the two former species (the field and house crickets) ruminate or chew the cud, like many quadrupeds." Hist. Selb. 295. p.

‡ "The sagacity of the white butterfly caterpillar deserves our admiration. Having fed itself its due time, it then retires to places of security. I have seen great trains of them creeping up the walls and posts of the next houses; where, with the help of some cobweb-like filaments, they hang themselves to the ceilings and other commodious places, and then become aurelia. In this state and situation they hang secure from wet and cold till the spring and warmer months, when they are transformed into butterflies." Derham, Phys. Th. p. 381.

§ "Two things are observable in their sagacity in this matter:

1. They are not driven by stress of weather to their retirement, but seem as naturally to betake themselves to it, as other animals do, to rest and sleep; for, *before* the approach of cold weather, toward the end of summer, we see some kinds of them flocking together in great numbers, within doors, as swallows do a little before they leave us, as if they were making ready for their winter's rest.

2. Every species betakes itself to a proper convenient receptacle:

Insects are admitted by all to have the sense of sight in a very perfect degree. Some at least show that they hear.* Their touch is also very nice. Their smell is frequently manifested. As they eat, and select what they eat, they must have a discriminating taste. All have an organization of nervous matter, similar to the nervous substance in quadrupeds and man. The same agencies of light, sound, heat, cold, electricity and moisture, which act upon our senses and nervous system, act upon theirs. Hence, as from the same causes operating on the same materials, the same effects must follow, it seems to be a just inference, not only that they have sensations from their organs and nerves of sense, as we have, but that those sensations must, as they proceed from them, and are felt in them, be like those which we experience. Caused by the same objects, and felt in the same nervous matter, we may infer that they see as we see, feel as we feel, and hear, when they do, as we hear. Our experience every moment verifies these conclusions. The fly is as quick of sight as ourselves, but moves far more nimbly.

But perceptions are the accompaniment of sensations, and if insects have organs of sense like ours, and if similar sensations accrue from similar nerves and senses, we may reasonably expect that the same sensations will produce, in sentient beings, similar perceptions. They must do so, or else occasion false perceptions of them. But insects seem to act as correctly on their sensations, as we do on ours, of the same things. Nothing indicates in them false perceptions of external objects. Ideas on all things spring from the perceptions of our sensations. Insects may therefore be presumed to have perceptions of their sensations analagous to our own; and if so, their ideas from these must have an equal assimilation, unless there is any thing in the nature of their mind to form ideas from their perceptions different from what we do from ours; but we only form the true

some under the waters, to the bottom of ponds; some under the earth, *below the frosts;* some under timber and stone, lying on the ground; some into hollow trees, or under the bark, or in the wood; some into warm and dry places, and some into dry alone." Derham, p. 381.

* The death-watch, or Ptinus, is an instance of insect hearing. It makes its ticking noise by beating its head with great force against what it stood on. Derham kept two in a box for three weeks, and found that by imitating their sound, which is done by beating with the point of a pin, or the nail, on a table, the insect would answer him, by repeating its own tick, as often as he pleased.

ideas of our perceptions. Either these insects must have the same ideas from their perceptions that we have from ours, or their mind must be of that erring nature as to form false, and therefore absurd, ideas from the same sensations of the same external things. That insect mind should be created of this falsifying nature, would be destructive of their well being, and is therefore improbable. All the use of sensations and perceptive faculties is to convey to the possessor exact impressions of external things, and to leave on his memory just ideas of them, that he may act, think and feel rightly concerning them. But every insect has to do this for its own preservation and welfare, as far as its granted faculties extend. Each class continually evidences discriminating perceptions in what interests their appointed comforts and nature, and distinguishes things apparently as we do. The tribes of bees see a flower as well as ourselves and go as directly to it, to examine or suck it, as we would do to smell or pluck it. They hear their own buzz and hum as we hear. They smell the fragrance that pleases us. With a true perception, they distinguish the nectarium of the flower from its other parts, and the sweet juice within it from the plant's common sap. The fly knows the sugar from the salt as well as we do. The flea as justly discriminates blood from water. The wasp mistakes not a pebble for a peach. External similitudes sometimes mislead them, but they soon ascertain the actual unfitness. We see all kinds of insects in the habit of exploring and examining what attracts them, as if assiduous to gain right perceptions about it. They discern and use what suits them, and leave what is contrary. They give, in their movements, repeated indications of what we find in ourselves to be perceiving, comparing and judging mind; and the similarity of the results leads us to infer a likeness in the perception and the idea, but confined to the limited compass which no animal overpasses. From light, indeed, a decided wrongness of perception or of judgment occurs to some. This is a mysterious point. They have some gratification from the radiant flame of a taper, which draws them to a destructive contact with it. But it is not the moth or other insects only which commit a fatal mistake on this sensation. Birds and fishes are equally allured by a strong blaze to their own misfortune. What it is that either expect to gain by rushing into the fiery light, we are not able to

ascertain. It is a fallacy of perception or judgment which quadrupeds more generally avoid.

That spiders hear the sounds we make; and when we attach artificial ideas to them, or make them the conveying medium of our ideas, do also on their part perceive our meaning in the sounds, and connect the same ideas with them, is evidenced by the fact of their coming for food when the musical notice is given to them.* A similar connexion of ideas with actions is also stated.† These instances imply memory also, which many facts satisfactorily indicate.‡

There seems to be reasonable grounds to infer that insects communicate their ideas and wishes to each other;§ and that ants perceive what another needs, and voluntarily assist him to attain his end.‖ Dr. Franklin inferred such a

* M. Pelisson, when confined in the Bastile, tamed a spider, and taught it to come for food at the sound of an instrument. N. Dict. d'Hist. Nat. 2, p. 273. Kirby, 4, p. 22. Nat. Hist. Ins. 1, p. 264. . . . . see such effects every day with birds and fowls. Having for some time opened my window, and thrown out crumbs on the gravel path, the moment the sound of the pullies occurs, as I lift up the sash, the birds fly to the spot from the neighbouring trees, and the fowls hasten to it from any distance within hearing. So at my dinner: the instant I open the parlour window, the sound draws immediately the poultry to it though I and my plate are not in their sight. They connect the idea of food with that particular sound.

† A manufacturer in Paris fed spiders in his apartment; and whenever he entered, which he usually did with flies on a dish, they immediately came down to him, to receive their food. N. Dict. ib. Kirby, ib.

‡ A swarm of bees lodged in an opening beneath some tiles. They were drawn from this place, and hived; but every year, for eight years, when the descendants of this stock were about to swarm, a considerable party of scouts always reconnoitered the old hole a few days before, and would have settled there if they had been suffered; but no bees did this of any other stock. They seem to have remembered their first settlement. Kir. Sp. 2, p. 528. . . . One autumn, some honey was placed on a window. The bees came to it in crowds. The honey was taken away, and the window was closed with a shutter all the winter. In the spring, when it was re-opened, the bees returned, though no fresh honey was laid, as if remembering and expecting it. Huber, 2, p. 375. Kirb. Sp. 2, p. 202.

§ A scarabæus was making a pellet of dung for the reception of its egg, which it rolled to the summit of a small hillock, but it fell into a hole, from which all the efforts of the beetle could not extricate it. After several ineffectual trials, the insect repaired to an adjoining heap of dung, and soon returned with three of his companions. All four now joined, and succeeded in pushing out the pellet; when the three assistant beetles left the spot and returned to their own quarters. Illiger, Mag. 1, p. 488. Kir. Sp. 2, p. 525.

‖ A writer in the Imperial Magazine states, "I saw an ant pulling with his mouth a piece of wood. The rest were busy in their own way;

communication between this class of insects, from a fact of his own observation.*

That insects have excitable passions, and can be irritated by mutual provocation to personal battle which they do not naturally seek, the Chinese have discovered, and inhumanly made the fact instrumental to their own amusement.† One species displays a spirit of cannibalism toward each other, which evidences that there are savage anomalies among insects, as among the uncivilized tribes of mankind.‡ That they examine objects, and move from place to place, to explore and to seek for what they want, and make movements of their proboscis to ascertain what is fit, and to imbibe what suits them, we see by all the flies which come upon us and about us, and in every winged or crawl-

but when he came to an ascent, and the load became too much for his ability to get it further, three or four came immediately behind, pushed it up to level ground, and then left him. The end he pulled was smallest, and as he drew it between two things, it stuck there. After several fruitless efforts, he went behind, pulled it back, and turned it round." Imp. Mag. No. 127, p. 637. This last fact is somewhat like what I have noticed in note p. 363. . . . . Plutarch mentions of ants, that those which have no burdens, make way for those who are laden with them.

* He found the ants feasting on some treacle in his closet. He shook them out, and suspended the pot by a string from the ceiling. One ant had happened to remain, and, after eating its fill, found its way up the string with some difficulty, crawled on it to the ceiling, and thence along the wall to its nest. In less than half an hour a great company of ants sallied out of their hole to the ceiling, and crept along the string into the pot. This was done by others, till the treacle was all consumed; one body running up the string from the sweet, while another passed down to it. The Doctor inferred that the first ant had communicated to its comrades the new position of their delicacy, and directed them to the only accessible road to it. Kalm's Travels, 1, p. 239. Kir. Sp. 525.

† To make two male crickets fight, the Chinese place them in an earthen bowl, about six or eight inches in diameter. The owner of each tickles his cricket with a feather, which makes them both run round the bowl different ways, frequently meeting and justling one another as they pass. After several meetings in this way, they at length become exasperated, and fight with great fury, until they literally tear each other limb from limb. Dobell's Travels in Kamschatka. The same people irritate quails into a duel combat.

‡ Sir J. Smith mentions that a male and female mantis were put together in a glass vessel. After a while, the female, who was largest, devoured her companion. Tour to Continent. . . . Rœsel hatched several, from eggs, in a large glass. As they grew, they began to attack and devour each other. Though divided into different parcels, the strongest in each community devoured the rest. Rœsel compares their battles to that of two hussars, for they guard and cut with the edge of their fore-claws as the men with sabres; and sometimes, at a stroke, one cleaves the other through, or severs its head from its chest. Bing. 4, p. 46.

ing insect that we may choose to observe.* They are all as busy with their head, mouth, its trunk, or their antennæ, on every thing which they reach, as a dog is with his nose; examining what they crawl over, and making perceptions of it, and judging whether they shall make it a part of their pleasures, use or nutrition, for these seem to be the objects of their movements—of their exploring functions.

But the insect mind peculiarly displays itself, in some tribes, in the habitations which they build for themselves, and in those which they prepare for their young. "The nests of birds, wonderful as they are, yet are eclipsed by the structures formed by many insects. The regular villages of the beaver, by far the most sagacious architect among quadrupeds, must yield the palm to a wasp's nest."† My restricting space will not allow me to illustrate these positions by a detail of the phenomena on which they are founded. I can only refer you to the testimonial illustrations of them. You will find these in the descriptions of the carpenter bee excavating in dry earth a sufficient area for her purpose; then building as many apartments on it as she will lay eggs, and putting in each an adequate store of pollen and honey for the young one when it emerges;‡ in the mason bee, who builds her maternal mansions of the sand, which she glues from her own fluids into an artificial stone, and who also deposits due provision for her future brood before she closes up their cells;§—in the other species, who build their parental homes of flowers, as some do of leaves;‖ in the curious architecture of the mason wasp;¶—and in the still more dexterous ones of the various lepidopterous tineæ.** Phenomena very much resembling architectural and building mind in the human race, appear in their actions and constructions. Nor are the spider galleries, with openings like doors, made to be as moveable as any upon hinges, less ingenious.†† All these things furnish elucidations of the deduction, that their principle of life

* "If a hive be removed out of its ordinary position, the first day after this removal the bees do not fly to a distance, without having visited all the neighbouring objects." Huber, Kech. p. 100. Kir. Sp. 2, p. 527.

† Kirb. Sp. 1, p. 435. M. Samouelle's "Entomologist's Compendium" contains a valuable "Calendar, exhibiting the time of appearance and habitation of near 3,000 species of British Insects." 357—444. It is arranged under the months, and distinguishes minutely where each may be found in England.

‡ Kirb. Sp. 1, p. 439.
‖ Ib. 443, 4.
** Ib. 458—466.
§ Kirb. Sp. 1, p. 441.
¶ Ib. 447.
†† Ib. 471

has generalities of perception, comparison, thought, reasoning, judgment and volition, so like our own, as to be distinguishable only by the difference between their very circumscribing limitation—and our, as yet, unbounded improvability. This difference is indeed immense, for Dr. Virey is nearly right when he affirms that "they are incapable of instruction, and can superadd no acquired habits to those which are instinctive and inbred."* This is almost the exact truth; but it must be qualified in these respects, that some can be tamed in a small degree, and taught or led to the acquisition of a few new habits; but the general position is generally true.

It is in the habits of those insects which live in societies, that we perceive the most extraordinary demonstrations of even intelligent intellect; for what other terms can we justly apply to that faculty within them, which leads or enables them to form political communities, with established governments, sovereignties, social ranks, and appropriated occupations; and also producing regulations or exacted habits of conduct resembling those enforced by human laws and polities. What seemed poetry in Virgil as to the bees, has been found to be only a part of the truth, as to their associations. The diminutive ants are still more extraordinary. The wasps display kindred minds and habits.† It is not possible to read of the wars and duels of the ants, or of the bees—to find them assemble in armies, make evolutions, and fight pitched battles—and to deny them a similarity of mind with those of their superiors, who have soldiers, tactics, and wars.‡ That ants have slaves; and make expeditions to capture other ants, to reduce them to servitude;§ that they should keep smaller insects, the

* N. Dict. d'Hist. Nat.—Kirby, v. 4, p. 21. Mr. Rennie also says, "social insects, as soon as they arrive at maturity, are invariably endowed with the same powers; unimprovable also, so far as we are aware, by any mode of management or of instruction." Insect Miscellanies, p. 293.

† The several works of M. Huber on the ants and bees, contain the fullest and most authentic accounts of the nature, actions and habits of these insects. The government of the ants may be also seen in the Insect Miscellanies, 297—305; and that of the wasps and bees, in p. 306—321.

‡ On the wars of the bees and wasps, see Insect Miscell. p. 322—531. . . . Kirby and Spence also state the battles of the bees, v. 2, p. 205—7. . . . Of the ants, "M. P. Huber is the only modern author that appears to have been a witness to their combats." Kirby, v. 2, p. 71. Mr. Rennie has noticed them in his Insect Miscell. 331—341.

§ Insect Miscell. 341—356. Messrs. Kirby and Spence describe these

aphides, in order that they may milk them, or extract from their bodies a saccharine fluid for their own nourishment, as we take the milk from cows;* and that they should keep assemblages of these, as their separate and private property;†—such actions and habits are too like our own, not to be considered as those of reasoning mind, not very dissimilar to that which we possess. All species of the ants, petty as they are in size and appearance, perform actions, possess and preserve institutions, and display faculties and capacities, which seem on the whole not to be inferior to those of any of the animal orders; indeed, to be superior to what is known, perhaps, of any. One kind of these are peculiarly useful to mankind, in consuming that dead animal and vegetable matter which, in warmer climates, would otherwise become a pestilential putridity.‡

extraordinary incidents, v. 2, p. 75—84. . . . "They will sometimes travel 150 paces to attack a negro colony." p. 81. . . . . The slaves are well used. "Beings so entirely dependent as these masters are upon their slaves for every necessary, comfort and enjoyment of their life, can scarcely be supposed to treat them with rigour or unkindness. So far from this, it is evident from the preceding details, that they rather look up to them, and are in some degree under their control." Kirb. Sp. 2. p. 85.

* Kirby, p. 87. It is on this process, that Linnæus, who has also noted it, says "the ant ascends the tree that it may milk its cows, the aphides, not kill them." Syst. Nat. 962, 3. . . . Turt. Linn.

† "Ants make a *property* of these cows, for which they contend with great earnestness, and use every means to keep them to themselves." Kirby, p. 89. . . "The greatest cow-keeper of all the ants, is the yellow ant of Gould, F. Flava. This species, which is not fond of roaming from home, usually collects in its nest a large herd of a kind of aphis, that derives its nutriment from the roots of grass and other plants. These it transports from the neighbouring roots; and thus, without going out, it has always at hand a copious supply of food. These creatures share its care and solicitude equally with its own offspring." Kirby, 89.

‡ The termites, or white ants, are peculiarly active and serviceable in this respect. "Nor is there any set of insects whose economy is more perfect. They exist together in kingdoms, and build cities, which are extremely populous. Mr. Smeathman has described the bellicosus species, in the Philosophical Transactions, from his observations of them in Africa. They build a cone rounded at top, four feet high, and of great extent. The walls are of clay, and so strong as to bear the weight of the heaviest animals. These contain a vast number of compartments. That in the centre always holds the king and queen; others are for her attendants, who are scarcely fewer than 100,000. They exist in the classes or forms of labourers and soldiers. When their cities are broken open, the soldiers march out with impetuosity, and attack every thing that comes in their way. Wherever they strike they draw blood, and frequently beat off the bare-legged negroes. As soon as the assailant is withdrawn, the labourers issue forth in prodigious numbers, and very speedily erect a new wall." Phil. Trans. v. 71, p. 139. . . . Thoms. Hist. Roy. Soc. 94—6.

The phenomena of the ant tribe deserve the study of the metaphysician, for displaying the possession and exertion of one of the most active and powerful forms of animal mind, in one of the smallest species of a visible body. They furnish another illustration of the great fact, that the living, sentient, and intellectual principle of animated nature, is essentially distinct from all material figure, substance, and size, and independent of them. Matter is the external investiture of mind, but can never rightfully claim an identity with it. The force of matter depends on density, magnitude, and impulse; on accumulation of particles, and external movement. But mind has its energy within itself, and is alike independent of configuration, bulk, or substance. It uses matter as its servant, but never originates from it. Its source is far more exalted and celestial.

The muscular powers of insects are still more superior to those of the greatest animals, than their comparative minds. Some amusing representations have been given of this difference.* They have also another peculiarity, unequalled, and not possessed by any bird or quadruped. They can reproduce the limbs they may lose.† Their diffusibility is also extraordinary, and in some species rivals that of plants. Hence, they may occasionally appear in the most distant countries, where before they were

* Linnæus remarks, that if an elephant were as strong in proportion as a stag beetle, he would be able to tear up rocks and to level mountains. . . . A cock-chafer is for its size, six times as strong as a horse. Kirby, 4. p. 190. . . . The flea and locust jump 200 times their own length, as if a man should leap three times as high as St. Paul's. Nat. Hist. Insects, 1. p. xvii. . . . The cuckoo-spit frog-hopper will sometimes leap two or three yards, which is more than 250 times its own length, as if a man should vault at once a quarter of a mile. Insect. Transf. v. 6, p. 179. . . . Mouffet relates, that an English mechanic named Brack, made a golden chain as long as a finger, with a lock and key, which was dragged by a flea. Mouff. Theat. Ins. 275. . . . Latreille mentions a flea of a moderate size dragging a silver cannon on wheels, that was 24 times its own weight, which being charged with powder was fired, without the flea seeming alarmed. N. Dict. Hist. Nat. v. 28, p. 249. . . . Kirby, 4. p. 188.

† M. Henneker found at Funchall, that the paws of the house spider were soon reproduced, especially in hot weather. So the antennæ of the clopesta, the wood louse; so in the aquatic salamander, as the claws and nippers of the crustaceous kind. He saw the blatter and reduves regain their paws and antennæ after amputation, especially their nymphes. So crickets and grasshoppers their forficules. Bull. Un. 1830, v. 4, p. 168. . . . Sir Joseph Banks had verified the fact as to spiders before. M. Samouelle quotes his account of it. Having lost five legs, the animal, on changing its skin, reproduced them; but they did not attain the size of the old ones. Sam. Ent. Comp. 120.

unknown.* Such is their vitality that they can also live in the heat and confinement of the human stomach.† As some fish and squirrels can fly, so there is a species of

* The larva of some insects float in the air, and are wafted by the wind. In October 1827, near Moscow, snow fell in a N. W. wind; and with it a considerable quantity of blackish larvæ veloutés. M. Kaneff gathered several. In a vessel of snow they lived some time; and in cold water; but those, put in a warm place, soon perished. . . . . Mr. Fisher thinks that they are taken up from the earth in violent winds. . . . Others of this kind fell near Zverrigorod, and in the winter of 1826 at Archangisky; others on a mountain near Moscow.

A similar phenomenon was remarked in November 1672, and in 1745, in Hungary. In 1749, "The ice of a lake near Sædermanland was covered with a great quantity of the same larvæ, which had been brought from the forests of Westermanland, where the wind had torn up several trees." Bull. Un. 1829, v. 8, p. 310. . . . . So Dr. Hempush, sailing from Trieste down the Adriatic, found their ship covered with insects brought by the wind. Bull. Univ. 1830. p. 53.

The occasional though rare appearances of locusts, show us to what extent insects may travel with the wind. Twelve years ago, I caught one at Epsom. This was a straggler. But the entrance into Ireland, in 1688, of a species of beetle, scarabæus melotontha, described by Dr. Molyneux, was a visitation of resembling devourers almost as formidable, from some distant shore. . . . . "Vast swarms were brought into Galway by a *south-west wind* during the day. They hung in clusters from the boughs of trees; but about sunset they took wing, and darkened the air with their vast numbers. It was difficult to make one's way through them, for they dashed themselves against the face, and occasioned considerable pain. They fed upon the leaves of trees; and the noise they made in eating was like the sawing of timber. For two or three miles round, every tree was stripped of its leaves, like the depth of winter. Smoke was found to be a preservative. The burning of heath and ferns kept or drove them out of gardens. Towards autumn they entirely disappeared, probably lodging under ground in a dormant state, for, next season, immense quantities of them were found in some places, in holes under ground. Their eggs became white caterpillars, which fed upon the roots of the corn, and destroyed the future harvest. Cold weather destroyed them *by millions*." Philos. Trans. v. 19, p. 71. Thoms. Hist. Roy. Soc. p. 92.

† Dr. Picknell details the case of a girl in France, who emitted the larvæ of beetles, the blaps mortisaga; and twelve days after a green insect, with wings, that flew away She continued to discharge others. Some were an inch and a half long, very vigorous, and lived a month in a box. He reckoned 400 of what he saw. Seven of them were the tenebris moliter, or meal-worm. The complaint continued for some time. He thinks above 1,300 larvæ came away in all; and of these 60 were winged insects; so that they changed, matured, and bred in her stomach. The cause was, that by an old woman's advice, she had drank water saturated with the earth of two catholic priests' graves. The blaps live in churchyards. . . . . Dr. Gaspard mentions, in the epidemy in 1826, a man who emitted three caterpillars. Another, a countryman, voided a yellow caterpillar, and asked if it could come from some apples he had eaten. In another case one was shown to Buffon, that was brownish, with sixteen legs; it refused leaves, and would only eat meat recently masticated. Bull. Un. 1830. v. 11, p. 213–15.

spiders which have the power of floating or moving in air.* But creation is full of analogies, pointing to one general originator, and linking all sentient things into one great family of related fellow-creatures.

* On the flying spider, see Bull. Un. 1830. v. 8, p. 345, 6. . . . . A species raise themselves in the air by their gossamer threads. Ib. 1829. v. 7, p. 133,4. . . . . See also the "Natural Hist. of Insects" in the Family Library, No. VIII. . . . . The actual truth is, perhaps, that which Leuwenhoeck observed; "the animal has the power of darting out a very long thread, *not attached* to any thing, by means of which it is wafted about in the air, where it often remains a considerable time." Thomson's Hist. R. Soc. p. 91, from Phil. Trans. v. 22, p. 867.

LETTER XVIII.

On the fossil remains of animals found in the rocks and strata of the earth.—I. Those in the secondary strata of the marine classes. —II. The land quadrupeds of the tertiary beds.—Nothing inconsistent with the Mosaic cosmogony.

MY DEAR SON,

THE other topics which remain to complete my objects in these letters will not allow me to detail to you all the facts that ought to be known and considered with respect to the fossil remains of animals which the rocks and strata of our earth contain, and which human labour or curiosity has disclosed, in modern times, to our view. To do full justice to the subject, the right theory of our geology ought to be first well settled. But the diversities of opinion which still prevail, show that this is impossible at present. We know enough for ingenious speculation, and also for hesitation and doubt; and we are from time to time acquiring more elucidating knowledge, which is leading the intelligent inquirers, who are pursuing this interesting subject, to better reasoning, and to more just conclusions. But we seem to have arrived at that point in which further discoveries from our mineralogical investigations become necessary, before any true system can be established as to the formation of our globe. Scientific men have traced its constituent substances to sixty or more simpler bodies, which at present rank as elements, because they are not yet further decomposable; and these appear to have constituted our primordial rocks. But there are abundant reasons for surmising that they are not the primitive elements of material nature; and therefore until they can be resolved into the particles or substances which are so, we shall not attain those perceptions of the original composition of our multifarious earth, which will present the deciding and satisfactory truth. We must know what silica, alumina, magnesia, lime, carbon, iron, and the other metals and primitive components of the minerals intrinsically are, before we can accurately discern the process of the succession, the causations, the agencies, the laws, and the principles, on which the primary and secondary masses were originally formed. The acquisition of this further

information would have been thought impossible in the last century. But human sagacity and industry are now exploring what is unknown, so perseveringly, and so successfully, that every month may bring us the information, that some diligent analyst, in some country or other, may be drawing from nature those great secrets of her primordial chemistry, which have hitherto been impervious and inaccessible. In this state of unsatisfactory ignorance and uncertainty, it will be sufficient to notice the organic remains which have been disclosed, with a few brief remarks on the subterraneous structure which contains them.

The ground we tread upon, and from which vegetation now springs, is not the primitive surface of the earth. It is the upper part of the last series of strata which have been deposited upon and around it, and which is now most commonly denominated the TERTIARY formations. By this term, the series of subterraneous beds, down to the chalk rocks, are named and known; and they are manifestly more recent than the masses below them.* These are considered by many, and, I think, justly, to have been formed at the period of the deluge, from the fragments and ruins of the earth's previous surface, amid the concussions and perturbations of that general catastrophe.† But, however this be, these tertiary beds are clearly distinguishable from the more ancient, and are treated of as a class by themselves, different from what preceded them in position, appearance, fossils, and composition.‡

Below these occur another great series of various rocks, of a stratified and sedimentary nature, which have been called transition, or intermediary, and upper and lower secondary.§ But to all these, the general term, secondary,

* Conyb. Geol. Introd. v—vii. M. de Serres Geogn. p. xcii.

† M. Dufresnoy calls the beds that have been deposited on the extensive chalk formation "Terrains Tertianes." Bull. Uni. 1831. No. 4, p. 38. . . . . "We find a mantle, as it were, of earth and sand indifferently covering all the solid strata, and evidently derived from some convulsion which has lacerated and partially broken up those strata, inasmuch as its materials are, demonstratively, fragments of the subjacent rocks, rounded by attrition." "Hence they must be assigned to the last violent and general catastrophe which the earth's surface has undergone." Mr. Conybeare, therefore, calls them diluvial. Out. Geol. p. 4.

‡ M. Marcel de Serres' "Geognosie des Terrains Tertianes," 1829, is devoted to this class of the earth's strata, and to their animal fossils.

§ "Transition or intermediate rocks cover those of the primary class, and are distinguished as the lowest rocks, in which the fossil remains of

as marking one great outline of chronological distinction, from both the earlier and the later, and as embracing the whole series, seems to be very fitly applicable.* This leaves that of primary, or primordial, for those crystalline and other masses which are found beneath them, and on which they rest, and beyond which, human knowledge has not penetrated. These are the granite, gniess, and mica slate rocks, with their subordinate resemblances.† All these are mainly formed of the same materials, in different proportions and modifications; quartz, felspar, and mica, with some occasional additions of a few other particles; and they are found in all regions of the globe, and of the same composition.‡

In these primordial rocks no organic remains have been seen; and from this circumstance it is reasonably and generally concluded that they were formed before animal or vegetable life began. It is in the secondary rocks, those that were deposited or composed after the primary ones were consolidated, and before the tertiary strata accrued, that fossil exuviæ have occurred.

The SECONDARY formations consist of new rocks, formed from the fragmentary ruins or disintegration of the primordial ones, or from new compounds of their constituent substances, with the addition of various successions of others of the calcareous or limestone classes. The most ancient of these are the argillaceous schist or clay slates, from which our various kinds of slates are derived; the conglomerates, grey wacke, and old red sandstone, the carboniferous or mountain limestone, the coal measures,

animals or vegetables are found." Bakewell Geol. p. 124. . . . . In these he includes the slate grey wacke and mountain limestone. His upper secondary class comprises the magnesian limestone; red sandstone; lias; oolites; sand; clay and chalk rocks (p. 236;) naming the coal formations his "lower secondary." 146.

* M. Marcel de Serres accordingly attaches the denomination of secondary to all these classes, distinguishing them into the three modifications of "upper, middle, and lower." Geog. p. xcii. . . . . This simplicity seems preferable, in a large outline of the subject, to M. Al. Brongniart's numerous minute divisions, with a long train of new Greek-derived names.

† Bakewell's Intr. Geol. p. 84, 5. Al. Brongn. Ecorce du Globe, p. 340, 1.

‡ "With the granitoid groupe all the earth is covered." Al. Brongn. p. 342. . . . . "Geologists have observed, that mountain masses display every where the same rocks; the same assemblage of mica, quartz, and felspar, in granite; of mica, quartz, and garnet, in mica slate; and of felspar and hornblende in syenite." Humboldt's Geogn. Ess. p. 4.

and their vegetable remains, which we have noticed in a preceding letter. The subsequent rocks above these, of the new red sandstone, the magnesian limestone and red marl, with the calcareous beds of lias and oolites, iron sand and green sand, follow. Above all these the chalk masses lie, that terminate the series to which the appellation of secondary has been conveniently appropriated.*

After these a new state and order of things begin in the tertiary rocks and strata, which are above the chalk beds, and which, in a succession and intermixture of clay, sand, marl and limestone strata, ascend up to our present inhabited surface. I will not enter into any detail on these, nor on their predecessors. It will be sufficient to have enumerated the whole in this general notice, in order to enable you to understand more satisfactorily to yourself the position and history of the fossil remains, which they have preserved, and now disclosed to our knowledge, of some of the former animals of the more ancient period of our earth.

All the animal remains found in any part of the secondary rocks and strata, are of those who inhabited the primeval waters. The great bulk of them are of the testaceous and zoophyte orders, with a few fish. Several of these are species which have now ceased to exist; but they are so analogous to the genera which still inhabit our seas, that they display no remarkable differences from them. These occur first in the clay slate, and abound principally in the mountain or carboniferous limestone. But in the lias of England, remains of the amphibious genera have been discovered, which have no similitude in any species that now appear, and which are really extraordinary, both in their size and figure.†

* To this second class of rocks, the valuable volume of Mr. Conybeare and Mr. Phillips, in their "Outlines of Geology," is devoted. . . . . The 11th, 12th, and 13th chapters of Mr. Bakewell's sensible work also treat upon them. The plates to his work are pleasing and satisfactory illustrations. . . . . Dr. Ure's Second Book of his Geology adds much important information; and much accession of matter and thought will be found on the same subject in several chapters of Dr. M'Culloch's Geology; and in the "Periode Saturnienne ou Antediluvienne" of M. Al Brongniart's Tableau. Paris, 1829. . . . I only regret his new nomenclature, as it is not likely to be generally adopted; and therefore perplexes the study of the science by a disadvantageous quantity of exotic terms, which do not seem to be either necessary or beneficial.

† On the fossils found in England in these secondary strata, Mr. Conybeare's chapters are the most original and satisfactory. The science is

One of the earliest beds after the primordial rocks, and into which mica slate is in some places seen passing, is the CLAY SLATE formation. In this rock, called also argillaceous schist, ichthyolites, or fossil remains of fish, have been found, in Switzerland, in Germany, France, Italy, Dalmatia, and Syria.* These antediluvian fish are those of several of our present genera.†

In the older LIMESTONES of Flanders, a great quantity of zoophytes have been observed. The madepores and millepores are abundant. The orthoceratites, which approach to that order of animals, also occur in considerable abundance, along with fragments of entrochi and encrinites.‡

No organic remains, either animal or vegetable, have been yet found in any TRAP rocks in England.§ In the carboniferous or mountain limestone, vertebral remains are very rare. There are many species, but few genera, of the testaceous class; "while the zoophytal families, particularly encrinites and corallites, are in the greatest profusion."‖

It is in the rocks above these that the saurian animals appear. Of the new red sandstone, and the magnesian or conglomerate limestone, which lie upon the coal measures,

much indebted to him, both as a discoverer and as a reasoner. Cuvier takes the lead of all, in his important work on this subject. Dr. Ure has ably brought together some of the most remarkable facts as to the antediluvian animals. And Mr. Parkinson, in his "Organic Remains," and "Outlines of Oryctology," supplies a fund of more particular information, especially as to the testaceous and zoophyte remains.

* The Article "Poissons Fossiles," in the Diccionare des Sciences Naturelles, details these fossils; and Dr. Ure, from that, has specified six localities of them in his Geology. p. 144—6.

† "In the famous locality of Monte Bolca (in the Veronese) the following genera are found: the shark, ray, file fish, sun fish, globe fish, balistum, trumpet fish, pike, lilurus, herring, pipe fish, cod, blenny, goby, mackerel, bull-head, gurnard, gilt-head, sciæna, perch, flounder, amia, fistularia, flying fish, murænophis, eel, dory, and several others." Ure, p. 147.

‡ Dr. Ure, p. 149. "The shells most frequently found there are terebratulites, turbinites, certain ammonites, and belemmites; but the only fossil which appears to be characteristic of the transition limestone, is the trilobite, a singular *extinct* animal of either the crustaceous or insect tribe." Ib. . . . . Mr. Bakewell's Geology contains a print of this, of the natural size.

§ Conybeare, p. 440.

‖ Conybeare, p. 356. . . . He particularizes vertebræ of fish, shark's teeth, and trilobites, with three kinds of chambered univalves; eight of those not chambered, and four of the bivalves. "Remains of the echini are occasionally found, but rarely." p. 368.

the first has no organic remains,* and the latter but few.† These are succeeded by the higher lias beds; and here some extraordinary animals have in our own days first come to light.

The lias formation in England stretches across from the coasts of the German Ocean, in Yorkshire, to those of the Channel in Dorsetshire.‡ It consists of thick argillaceous deposits constituting the base on which the whole oolitic series reposes. The upper portion of the lias, nearly two-thirds of its total depth, comprises beds of a deep blue marl, containing only a few irregular and rubbly limestone beds. In the lower part, the limestone beds increase in frequency, and assume the peculiar aspect which characterizes the lias.§ Its organic remains afford a greater number of vertebral animals than any other lower formation. Among these are the relics of two very remarkable extinct genera of oviparous quadrupeds of the lizard classes, but differing essentially in structure from any that are now known to exist.‖ These have been named the ichthyosaurus and the plesiosaurus.¶

The first of these, the fish lizard, was first described by Sir Everard Home, in 1814;** but more remains being found in the succeeding years, he enlarged his account, which has been completed by the additions of M. La Beche, Mr. Conybeare, and Dr. Buckland,†† with the assisting remarks of M. Cuvier. This animal has scarcely yet occurred in the continental rocks, but is peculiarly abundant in England.‡‡ Its head resembled the lizard tribe, but extended into a long

* Philips and Conyb. p. 282.

† "These are rarely met with in the limestone." The impressions of a fish, an encrinite, alcyonite, and some bivalves and entrochi, are noticed. Ib. p. 305.

‡ Conyb. 270. § Ib. 261. ‖ Ib. 265.

¶ Of these, Cuiver remarks that "it is in England especially that their remains appear to be abundant; and it is to the zeal of the English geologists that our knowledge of them is due." Ure, p. 227.

** In Philosophical Transactions for 1814; and afterwards in 1816, 1818, 1819, and 1820.

†† See the Memoir of Mr. Conybeare and M. La Beche, in Geolog. Trans. for 1821.

‡‡ "Its remains are deposited, from the new red sandstone up to the green sand immediately below the chalk. Hence it belongs to almost every epocha of the secondary formation. But it is especially the lias, that bluish gray, marly and pyritous marble, which seems to have been its sepulchre." Dr. Ure, p. 231. . . . Very lately there has been discovered a skeleton, almost entire, at Boll, in Wirtemberg. Ib. 232.

pointed muzzle, armed with numerous conical teeth, with a tail.* Its length varied from three to nine feet.†

The plesiosaurus we owe entirely to the sagacity of Mr. Conybeare. From several bones which he discovered, he inferred the existence of another animal, different from the preceding, and sketched its probable shape, in 1821.‡ Three years afterwards, Miss Anning found a skeleton of it, almost complete, that was lying on its belly, nine feet six inches long, having a neck that must have been longer than the swan's.§ Some bones and palates of the turtle, fish of several species, a few crustacea, and several testaceous molluscæ, have been met with in the lias beds.‖

The oolitic series of rocks which occur above the lias and below the chalk, contain a more varied series of remains than any of the former; land animals, birds, insects, amphibia, fishes, shells, and vegetables.¶ Of these the most novel and curious is the megalo-saurus. It was an immense animal, for its remains imply that it was forty feet long and twelve high. They were discovered by Dr. Buckland in the calcareous slate of Stonefield. Its lower jaw, vertebræ and extremities, are preserved in the Oxford collection.** Crocodiles, tortoises and gigantic lizards, have been found in the calcareous strata of the Continent. In one at Maestricht, that named the mœsa-saurus, was a lizard larger than a crocodile.†† Among the secondary strata of Sussex have

* Conybeare, p. 266. "Two eyes of enormous magnitude must have given its head an extraordinary aspect, and have facilitated its vision during the night. It naturally breathed air, and not water, like fishes. Hence it was often obliged to come to the surface. Its short, flat undivided limbs allowed it merely to swim." Ure, p. 235.

† M. Cuvier's smallest skeleton was three feet and a half long, of which the head and tail were each one foot, leaving one foot and a half for the body. His great one's head was two feet and a half long, and therefore must have been nine feet altogether. Miss Anning's was five feet long. She is said to have discovered another, twenty feet in length. Ure, p. 236.

‡ See his Memoir conjointly with La Beche, in Geol. Trans. v. 5. He named it plesiosaurus, or "akin to lizards," because he thought it more like them than the ichthyosaurus.

§ "A true serpent neck, on a trunk, whose proportions differed little from those of an ordinary quadruped." Ure, 241. . . . . It had 35 cervical vertebræ, and 6 with the dorsal ribs; 21 in the back and loins, and 26 in the tail, and 2 sacral, making 90 in the whole. Mr. Conybeare thinks it may have swam on the surface of the water, arching back its long neck like the swan, and darting it down at the fish that came within its reach.

‖ Conyb. Geol. 267. ¶ Ib. 206.

** Conyb. 208. Ure, 219, 20. Cuvier, Ossem. Foss. v. 5, p. 344.

†† Ure, 218.

been also found the teeth and bones of an herbivorous reptile, which has received the name of the iguanodon.*

The green sand abounds with organic remains, distinguished for their mass and beauty, but of none of the higher animals. They are mostly testacea, but exceedingly numerous.† The chalk formation comprises several fish, many testaceous molluscæ, and zoophytes.‡

Upon, and therefore above, the chalk, the TERTIARY ROCKS and strata have been deposited. These consist of various beds of sand, clay, marl, and imperfectly consolidated limestone. In England, they occupy two extensive tracts, each circumscribed by hills of the chalk formation.§ The uppermost beds of this series, being formed by causes still in operation, are of very limited extent, and are called ALLUVIAL.‖ "Next in order to these, we find a mantle, as it were, of sand and gravel, indifferently covering all the solid strata, and evidently derived from some convulsion, which has lacerated and partially broken up those strata." In these deposits, and almost in these alone, the remains of numerous land animals are found; many of them belonging to extinct species; and many others, no longer indigenous to the countries where their skeletons are thus discovered. These are the DILUVIAL strata."¶

The fossil remains of the tertiary differ greatly from

* Mr. Mantell described it in the Phil. Trans. for 1825, as found in the sandstone of Tillgate Forest. It is inferred to have been amphibious, inhabiting rivers or fresh-water lakes; with a horn; and, reasoning from the size of its teeth, to have been 60 feet long.

† Conyb. Geol. 128—131.

‡ Conyb. 72—5. "The important family of echinites may be considered as characteristic of this formation; and at least as equaling in number all the other shells found in it." Ib. 73. . . . There are several genera of the encrinus zoophyte, p. 74. . . . "The families of the alcyonium and sponge, present numerous remains." Ib. . . . Lamarck thinks the sponges to have polypi, like the alcyonia.

§ "The most northerly of the subjacent chalk strata on which the tertiary rest, is named the London Basin; the southerly, the Isle of Wight Basin." Ure, 292.

‖ "They consist in the accumulation of sand and shingle along the sea coast, and particularly in estuaries; in the formation of new lands on the banks of rivers and lakes, by the alluvial depositions they carry down, assisted by the growth of aquatic plants; in the growth and increase of marsh land; in the accretion of calcareous tufa, from the deposit of springs running through limestone rocks, and the like." Conyb. Geol. p. 3.

¶ Conyb. p. 4. "The tertiary rocks are:—I. Plastic clay, immediately over the chalk. II. London clay. III. Fresh water formations. IV. Upper marine formations, crag and bagshot-sand." Ure, p. 292.

the anterior ones, and mostly resemble our present living species. In the LONDON CLAY beds, no zoophytes occur, or they are very rare. Echinites, so common in the chalk, are here unfrequent; but testaceous molluscæ are numerous, and beautifully preserved. Many species of the crab and lobster are seen; several vertebral fish, finely preserved; and also, turtles and crocodiles.* No marine fossils have been detected in the lower fresh-water formation beds.†

It is in the superficial stratum of mingled sand and gravel, which covers almost every region of the earth, in situations beyond the reach of river deposits, and to which the name of diluvium has been given, to denote the detritus of the deluge, that the fossil bones of ancient animals are usually found.‡ Kindred skeletons, or their parts, have been discovered also, in great numbers, in the limestone caves of this and many other countries; supposed to have been the dens of antediluvian animals; the last tenants of which were drowned in the universal deluge.§ Many of these animals are like those which now subsist. But several of the fossil elephants, rhinoceroses, bears, and hyænas, exhibit, both in their individual bones and their mutual adaptation, great differences from their living types.‖ We owe the largest portion of our knowledge on this curious subject to M. Cuvier. He has determined and classed the remains of nearly one hundred quadrupeds, mammiferous or oviparous; of which, seventy species were previously unknown to naturalists; and among these, forty belong to new genera.¶ His first order is the pachydermata, or, thick skinned animals, comprising thirteen genera of the non-ruminant, but hoofed quadrupeds.** Of those which he describes, I will only call your attention to the largest and

* Conyb. p. 28. "Among the organic exuviæ of the plastic clay beds, we have ostreæ, cerithiæ, turritellæ, cytherææ, cycladeæ, &c. along with the teeth of fish." Ure, p. 294.

† Ure, p. 306. "Their organic remains are, lymneus, planorbis, and cyclostoma; perhaps the lelix, and a bivalve resembling the fresh-water muscle." Ib.

‡ Ure, p. 499. § Ibid. ‖ Ibid.

¶ Ure, p. 513. "Of the hundred species, about one-fourth part are oviparous quadrupeds; and the rest are mammiferous. Among the latter, more than one-half belong to non-ruminant animals." Ib.

** There are, the elephant, mastodon, rhinoceros, hippopotamus, tapir, hog, horse, daman, pecaris, phacocheres, anoplotherium, palæotherium, and elasmotherium. Cuvier, Oss. Foss. v. 4. . . . Dr. Ure details the chief facts as to each of these, from Cuvier, p. 519—543. . . . He adds the lophiodons, 543; the megatherium, 545; and the fossil bear, 562.

most novel. The MASTODON, of which he has distinguished six buried species—an animal of the size and figure of the elephant, with proboscis and tusks, yet distinguished from it by its teeth.* Of the gigantic fossil TAPIRS found, one species was eighteen feet long and eleven high, which equals it to elephants and to the great American mastodon.† The LOPHIODONS were a genus akin to the tapirs, by their teeth and size.‡ For the first knowledge of the large MEGATHERIUM we are indebted to the Spaniards, who discovered its remains in South America. Its skeleton is thirteen feet long and nine feet high. Its teeth prove that it lived on vegetables; and its robust feet, armed with sharp claws, testify that it was chiefly their roots which it sought after. Its magnitude and its talons supplied it with abundant means of defence. It was not swift in running; but this was unnecessary, as it had no occasion either to pursue or to fly. It has the head and shoulders of a sloth, while its limbs and feet exhibit a singular mixture of characters belonging to the anteaters, and to the armadillos.§

The magalonyx is another large fossil animal of the edental family, of whom a few bones only have been found in a cavern in Virginia.‖ Besides these extinct animals, there have been found in our diluvial soils fossil bones of the hyæna, tiger, bear, wolf, fox, weasel, ox, hog, and beaver. These occur with others such as the rabbit, water rat, glutton, and birds, in the bone caverns of calcareous rocks, and in the fissures of the breccias on the Mediterranean shores.¶ The fossil stag is a species with gigantic antlers. The fossil bear was one-third larger than the largest of our brown bears. His remains are very numerous and general. The fossil hyæna was more powerful than the present ones.** Some species of the tiger or lion

* Ure, p. 527.... M. Cuvier concludes that no bones of the great mastodon have been hitherto found in Europe. They occur most abundantly in the brackish marshes on the Ohio. Cuv. Oss. Foss. v. 4...Ure, 528. "The mastodon must have made the same use of its teeth as the hog and hippopotamus, which possess the same dental characters." Ure, p. 530.

† Ure, p. 542. ‡ Ib.

§ Ure, p. 549. "The term megatherium, signifies a huge wild beast."

‖ M. Cuvier decides it to be different from the megatherium. It is called magalonyx, from the magnitude of its claws.

¶ Ure, p. 550.

** Dr. Buckland's description of the cave of hyænas at Kirkdale, will be found, like his other works, very interesting, and full of enlarged views and information. His Reliquiæ Diluvianæ deserves every attention.

kind has also left remains, to indicate their existence. The modern limestone formations are full of cavities and caverns; and these have been found to abound with fossil bones of these antediluvian animals.* In some few of these, human bones occur; but the era to which their possessors ought to be referred, has not been yet satisfactorily ascertained. Though some are more modern, others seem to claim justly an antediluvian antiquity.†

From this brief review of the fossil remains of the primeval animals, and from our former chapter on the ancient vegetable relics, you will perceive that they both begin with the secondary formations of our earth, and therefore were called into existence after the primordial rocks had been placed and consolidated. All the animal exuviæ that occur before the tertiary beds, are aquatic animals, of one sort or other; and the far largest part are of the testaceous and zoophytal order. It is with the tertiary and diluvial fragmentary masses and strata that the mammalia or land quadrupeds appear. This announces that they were formed the latest and diffused the least and the most slowly. It is quite natural that the sea creatures should spread them-

* Dr. Ure has made a valuable summary of the chief facts of the bone caverns, in his Geology, 557—592. . . . M. Cuvier has also discriminated fossil dolphins, and a fossil lamentine, a genus resembling our seals, and which is now peculiar to the torrid zone.

† Human bones have been found in several places. Donati noticed them in the mountains of Dalmatia; and Canobio, in a calcareous tufa near Genoa. Bull. Univ. 1826. p. 22. . . . . M. Boue saw them, in 1823, behind the lake in Baden; and Count Razoumovski, in Lower Austria, mixed with quadrupeds partly extinct. Count Breuner also found them near Krems, in Lower Austria. M. Sterberg met with them at Kostritz, in Saxony. Germar confirmed Donati's account of those in the Dalmatian breccias. Others have been seen among the Caraibs and the inhabitants of Chili. Bull. Univ. 1830. p. 296, 162. . . . . At Torquay, pieces of pottery, siliceous axes, and other works of art, were found in the diluvian ossifere clay. Ib. p. 386. . . . . In France, human bones have been a short time ago discovered in two caverns in the Department du Gard at Poudre and Jouvignarque, mixed with mammalia ones. Acad. de Scien. . . . Others, also, at Bize, in a black mud, with those of lost animals. Bull. Un. 1829, p. 237. . . . . M. Renaux saw human bones in 1820, in a grotto of jura limestone, at Dufort. Ib. 1830, p. 30. . . . . M. Bernardi describes them as occurring with those of hippopotami and others, in a grotto at Mount Griffon, near Palermo. Gior. Offic. de Palermo, Ap. 1830. . . . . A human skeleton was found in Travestin, in Auvergne, and a fossil human head in the Travestins of St. Alisse, at Clermont, by Le Coq. In the same locality, M. Peghoux observed bones of domestic animals mixed with pottery, and many fragments of human bones. Bull. Un. 1830, p. 407. And see Marcel des Serres' observations on the human bones which he and M. Tournal discovered, in Bull. Un. 1830, p. 34, 6.

selves the earliest and the most universally. The sea surrounds the earth, and for a time overflowed its whole surface.

But although the rocks of the earth are distinguishable into the three divisions of the primordial, the secondary, and the tertiary, yet, as there was only one general creation of our globe—that, which Moses has recorded—the elementary materials of all these three classes must have been in existence at its commencement. All the substance that forms them may be assumed to have been in being from the time that the creative fiat was issued, and that its operative agency took place; and in this case, the secondary and the tertiary masses would not be new creations, of later epochas; but only new arrangements, structures, and depositions from the older matter of the primordial ones, and of the other elements and things co-existing with them; of which, the chief is recorded to have been water. This, according to the Hebrew historian, accompanied the earth from its commencement, and was in the first stage attended by intermingling light, which, in its modifications, is also heat and fire.

With this general outline, the main facts that have been ascertained seem to correspond. The secondary rocks are either new compositions from the fragments, or disintegrations of some of the granitic and primordial series, or are new formations from water and marine animals; or are the products of vegetable life. The fracture and decombinations of the upper portion of the granitic rocks, and the eruption of subterraneous ones of this class, in the form of molten or fluid granite, and of its posterior trap, will account for the sandstones, slates, and clays, and their interspersed or incumbent trap and basalt. From the waters of the ocean and on land, and the marine animals which were ordered into existence, all the limestone and calcareous rocks, of every species, appear to have originated.

The coal is now unanimously referred to a vegetable parentage; and every season from the birth of creation, must have been adding new layers of organic mould on the previous surface, from the natural decay of every year's successive reproductions. Thus, the primordial rocks, water, vegetation, and animal existences account for the matter of all the secondary rocks. But no one disputes that the tertiary have been formed from the fracture, the ruins, the disintegration and decomposition of those which had preceded them; and principally of the secondary, with addi-

tional volcanic eruptions of the primordial, in many regions, and with all the additional mould and matter which the decaying remains of the vegetable and animal kingdoms have been every year steadily and successively adding to the variegated mass. Thus there is no incongruity between the Mosaic account and these geological facts.

This venerable and invaluable outline of the primordia of our globe begins with a general declaration, that the earth originated from the creation of God.* Its first unformed, dark, and void state, is noticed with the waters upon it; upon which the spirit of ELOHIM is represented to have been in active operation. The results of his agency are not detailed, nor is any chronology affixed to this period of our terrestrial formation; nor is any account given of the geological constructions that ensued. Our science is therefore left at full liberty to investigate and delineate, what it may discover to have been the actual process, by which the construction of our planet was accomplished. —

The Mosaic chronology begins with the formation of Adam, and with the six preceding days or periods, which commenced with the production of light. What interval occurred between the first creation of the material substance of our globe, and the mandate for light to descend upon it—whether months, years, or ages, is not in the slightest degree noticed. Geology may shorten or extend its duration, as it may find proper. There is no restriction on this part of the subject. In this portion of time, or eternity, we may place the formation of our elementary matter—the composition and arrangement of the vast central and interior contents, whatever they may be—and the construction, circumambiency, and consolidation of all the primordial rocks; and, indeed, the production to all things to which light was not essentially necessary.

After announcing the production of the atmosphere, the separation of the seas, and the creation of the vegetable and animal kingdoms, the Mosaic record makes no further allusion to the state of the earth, until the catastrophe of the deluge. This interval was at least a period of one thousand six hundred and fifty-six years; and therefore allows that

* As the word bara, created, has an obvious affinity with bar, a son, and probably was derived from it, the pleasing idea of filiation is connected with creation, in the natural etymology of the term used by the sacred historian to express it. This is in gratifying unison with the repeated intimations of divine revelation, that the Creator deigns to consider himself as the father of his earthly creatures.

space of time for all the formations between the primordial and the tertiary. The violent changes which occurred at the diluvian ruin, seem to be most connected with the tertiary geology. Yet even as to this revolution, Moses says no more in express terms than that the fountains of the great deep were broken up. All additional matter, as to the terrestrial alterations at this epocha, can be but inferences from the other facts he mentions. Thus the sacred historian gives the largest latitude for the investigations and deductions of geological science; and presents nothing to our view, that is likely to be hostile to the actual truths which may ultimately be established, by that union of genius, knowledge, correct reasoning, and sound judgment, from which the great laws and principles of geology will be, as those of astronomy have been, so successfully discovered and determined. We have only to take care not to confound diffusion with creation; and therefore to remember that the first production of animals and vegetables were in such part or places only as was most fit. It is most probable that this was in some suited locality only, and that they were left to the appointed laws of their being, to disseminate themselves gradually according to their respective natures and qualities. A due recollection of this principle of natural diffusion, according to their respective powers and dispositions, will preserve your mind from many of those extravagant hypotheses and speculations which seem to have superseded the nursery and fairy tales of the continent, only to resemble and to rival them. But I hope that this panorama of creation which I have imperfectly endeavoured to delineate, will preserve your mind from the phantasms of philosophy, as well as from those of ignorant superstition. Each has its follies and its idols, from which the sound judgment will endeavour at all times to keep free. To separate the Deity from his works, is to surrender our intellect to error and to evil, and not less to discomfort. Look, then, upon nature as his intelligent and benevolent production; and enlarge your mind by surveying it in all its richness, grandeur, and diversity. This will make your ideas of him more sublime, and your feelings to him more grateful, affectionate, and duteous. To lead you to this happy result, and to assist you to arrive at it, has been the great motive and object of this literary correspondence. May it fulfil my earnest and anxious wish! True felicity will not otherwise be attained.

LETTER XIX.

Further considerations on the living principle in plants and animals, and its immaterial nature.—Division of existing things into the material and immaterial.—The four great classes of the latter.—Its possible connexion with other systems.

We have now surveyed succintly all the material forms in which the living principle appears on earth, except the human frame. We have found it to be invested, in the different kingdoms and individuals of nature, with very dissimilar configurations, and displaying such qualities in all as these varying structures have enabled or assisted it to exhibit. Let us bestow a few thoughts on the diversities of its appearance, and endeavour, from the phenomena which they disclose, to form, if possible, some notions of its real nature, or at least attempt, with cautious and moderated freedom, to suggest a few reasonings upon it. We will begin by considering it in its connexion with the vegetable kingdom.

Nothing seems more clear to our perception, when we allow no previous theory or prepossession to obscure its discernment, than the fact already alluded to, that life is not the material frame which it animates. From our consciousness of ourselves, from our observations of others, and from the phenomena which the living principle exhibits in all the departments of nature we have examined, this grand physiological truth emerges to our view. I feel it most satisfactorily in myself; and the more strongly as my body becomes weaker, more infirm and inefficient, while my mind retains all its faculties, activities and power of operation. What is thus true of life, wherever we can adequately discriminate it, we may consider it to be so in each of its forms and abodes where we can less investigate it; and therefore in plants as well as in animals, and in these as well as in man. Life I would therefore assume to be a principle in vegetation distinct from its material substance, and additional to it. But to live, is to be. Life is being. Vegetables, from having it, are therefore living beings; living in those peculiar configurations which distinguish their different classes.

But by a living being, we usually mean a living person-

ality of some sort or other—that which feels, and thinks, and wills. Are vegetables living beings of this description?

All animals that feel, have a nervous organization, by which their sensations occur to them. Plants have a medulla or pith which ramifies into their most important parts, and accompanies their most important functions, and which seems to be essentially operative in their growth and vigour. But pith is not nervous matter. On this, there can be no mistake; the eye and touch, as well as the chemist's decomposition, prove their dissimilarity. Pith, therefore, cannot be attended with the same effects to vegetables, which their nerves occasion to the animal classes. It is thus manifest at once that plants cannot possess nervous sensitivity.

The principle of life within human beings, and apparently in most animals, is attended with the feeling of pain or pleasure; with the perception of external objects; and with a power of associating, remembering, comparing and judging of the sensations and ideas which occur. Were plants created to have such sensibilities, or have they acquired them since their primitive formation? The first president of the Linnæan Society, and chief founder of our botanical school, was inclined to allow them a sort of conscious sensitivity.* Dr. Darwin, their elaborate poet and enthusiastic friend, went much further; and gave them not only sensitivity, and organs of sense, but also a passion of love, a common sensorium, dreams, ideas and self-consciousness.†

* To such a question, the amiable first president of the Linnæan Society deliberately answers; "as they possess life, irritability, and motion; *spontaneously directing* their organs to what is natural and beneficial to them; and flourishing according to their success in supplying their wants; may not the exercise of their vital functions be attended with some share of sensation, however low; and some consequent share of happiness? However this may be, the want of sensation is certainly not to be proved with regard to vegetables." Introd. Bot. p. 4.

† After stating the facts on which he grounds his deductions, he declares, "vegetable life seems to possess an organ of sense, to distinguish the variations of heat; another for the varying degrees of moisture; another of light; another of touch; and probably another, analogous to our sense of smell. To these must be added the indubitable evidence of their passion of love."

"And I think we may truly conclude, that they are furnished with a common sensorium belonging to each bud; and that they must occasionally repeat these perceptions, either in their *dreams* or waking hours; and consequently possess *ideas* of so many properties of the external world, and of their own existence." Darw. Zoonomia, v. 1, p. 145, sect. 13.

The calmly reasoning Dr. Hartley thought that their sensations could not be disproved.*

We may unhesitatingly answer on this inquiry, that as plants have not nervous sensitivity, they cannot have the animal feeling of pleasure and pain; and as they have not the animal eye or ear, they cannot have his perceptions from what he sees and hears, and therefore not his ideas, nor any such intellectual materials as he has for his capacity to act upon. Whatever faculties they may have, they cannot have animal sensations, perceptions, ideas, images or emotions.

Yet a living being may be a living personality without these. All these arise to the animal and to ourselves, from our nervous organizations, and principally from those of our eyes and ears. But without either of these, the animal mind would be what it is, independent of these, and what it was before they accrued to it. So the vegetable mind, whatever it be, and whether its living principle deserves such a name as mind, or not, must be what it is, though it has none of the ideas or sensations of the animal. It will subsist with its own original and essential qualities and properties, such as they are, and whatever they may be found ultimately to be.

But to have a personality of mind and character, plants must have the faculties of self-consciousness, moral sensitivity, moral perception, and moral volition. They must feel that they exist; they must be sensible of a difference in actions, as to their rightness or wrongness; they must be able to discern which is either of these; and they must spontaneously direct their will, and by that their conduct, according to their feelings or judgment.

All moral beings must have sufficient liberty of agency on their moral perceptions and volitions, or they can do no moral actions, nor exhibit a moral character; and they must be in a society of other beings who will be affected by their conduct, or occasion their moral principles to be in application and operation. Plants have not this freedom of action, nor this social state. Each is insulated from the other, without needing or giving any mutual assistance: neither act on the other; and their living principle is in a fixed and rigid frame, which it cannot move out of its rooted position. All

* "If vegetables have sensation, which may indeed be a speculation very foreign to us, but is what we cannot disprove." Hartley on Man, v. 2, p. 404.

its shoots and fibres are of the same character. It can fan the air with its leaves, but it is under the strictest confinement of material necessities, and can only be what it is, and live as it does; acting in its interior functions and vascularity, but passive and inactive as to every other being in nature, except as it exhales its fragrance, and presents its flowers and fruits to all that approach. Thus plants having no actions towards others to perform, no duties and no social offices, have no moral choice to make, no moral knowledge to acquire, and no moral agency to exert. Plants therefore are not made or meant to be moral beings, and cannot, from any of their qualities, attain or exhibit a moral character. Hence their principle of life has not this species of personality; they are not moral persons; nor can their living principle love, dream, feel, or think, as animals do.

But may not plants have that interior personality which arises from self-consciousness, though without any other intellectuality, and without any communication of the perception to others? They are not more fixed in their localities than the oyster, nor so denuded of vascular mechanism as the polype,* nor more apparently insensate than the

* The fresh-water polype, hydra virides, "is a small lump of transparent jelly of the size of a pea only, when contracted; but about three-quarters of an inch in its extended state, like the finger of a small glove with a few ravellings round the edge. It has neither wings nor legs; nor bones, nor muscles; yet it protrudes its tentacula, moves from leaf to leaf, and from stone to stone. It quits the dark, and approaches the light side of the vessel where it is kept. It basks in the sunbeam, enjoys the warmth of summer, and becomes torpid in cold weather."

Some of these may be turned inside out without injury, and seem the same animal either way. Yet, "it retreats if touched, and defends itself if attacked. It pursues its prey with avidity; and though it has neither tongue, teeth, nor palate, yet it devours as if with relish, and forces the smaller animals of its own kind into its simple pouch or stomach. M. Trembly saw two fighting, and the one swallow the other, his own son.

"It has neither eyes nor ears, nor any of the ordinary organs of the senses; yet it sees and feels, for it is sensible both to light and touch. Every part of its body is equally sensible to the various stimuli which affect its system, as if it were an eye or an ear all over." Mr. Burnett, Quart. Journ. Science, No. 12, p. 283.

Its power, when divided, of growing into the full animal in its severed parts, resembles that of the crustaceous animals reproducing their claws, and of plants shooting out into buds and branches; but M. Meyer found that they produced eggs containing young polypi in an embryo state. He discovered this by observing vesicules of the size of a poppy seed, swimming in the water, where he kept his polypi. They had a vibratory motion; and in every egg were two embryos. Bull. Univ. 1829, v. 8, p. 314.

animal sponge.* Can we grant to either of these a perceptive consciousness of its own existence, and deny it to the vegetable? Perhaps not. We can only say that the sensitive consciousness of the plant, however analogous in the personal entity, must be very unlike in the sensation. It cannot be that nervous feeling which, in animals, accompanies their nervous organization. It must be in the plant, if it exist at all; and if any enjoyment follows from it, of a kind peculiar to itself, and known only by itself; which no animal sensitivity resembles and of which, therefore, we, from the want of an original sensation of it, can form no image or idea. That it has very active energy, is evident from its power of forming the substance of its own body out of the unlike elements of nature.†

In ANIMALS, the living principle is more intelligible to us, because it displays actions and qualities which resemble our own. They have also a brainous and nervous system of the same kind of material substance, and with great similarities of parts, functions and distribution. But these bodily auxiliaries must not be mistaken for the living principle itself. That may, for aught we know, be the same in the vegetable as in the animal, in its essential nature, though it exhibit to our observation very dissimilar properties and agencies, from having an organization to actuate so different from the immovability or rigidity of the fibres of the plant. Whether the principle of life which exists within the tree would perform the same actions, and display the same powers, as the bird or the mouse, if it were to grow up in bodies of nerves, flesh, and bones like theirs, we cannot say. The

* "Count Maiselé, who had the most favourable opportunities of examining into the nature of sponge, was satisfied that he had many times observed a regular systole and diastole taking place in some of its more circular apertures. But neither M. Peron nor M. Bosc have been able to confirm these observations." Parkinson's Outl. Oryctology, p. 34. ..... M. Lamouroux has distinguished 161 species of sponge, in his Hist. des Polyp. Flexilles. Mr. P. gives the list from him. 35—48.

† The energy and even creative agency of the living principle of plants appear in its power of converting material particles into other substances. ..... "Experiments on vegetables seemed to prove, that the solid matter which entered into their composition in the more advanced period of their growth, must, in part at least, have been produced by some action of the vital powers, and could not have been obtained ab extra." Bost. Phys. 2, p. 387. Dr. Thompson's Chem. 4, p. 320. ..... Braconnot concluded that organic force, aided by solar light, developes in plants substances which have been regarded simple, such as earth, alkalies, metals, sulphur, phosphorus, carbon, perhaps azote. Ann. Chem. 61, p. 187. Bost. p. 387.

phenomena of each are too unlike in their different frames, for us to be able to separate the effects of the mechanisms from the natural power of their actuating principles. But it is not so between the various classes of the animal kingdom. Here we can perceive such a general resemblance of system of construction, however different in size and figure; and such a similitude of action and feeling between the ant and the lion, the beaver and the building bees, the elephants, the monkeys, and ourselves, that we have no difficulty in admitting that the living principle may be alike in the quadruped, the fish, the bird, the amphibia, the insect, and the worm. In each of these it displays affinities so similar, often so identical, that there does not appear any sufficient reason for supposing that each of these classes has a living principle peculiar to itself, and distinct in nature from every other. The mind of an ant does all that larger animals perform, and more than many. The wasp is as intellectual as the wolf; the lizard is as playful as the squirrel; the fish, the spider, the sheep and the serpent, may be alike tamed, and taught to come, when called, for their food, and to take it from your hand like the turkey and the lamb. All animal mind may therefore be of the same congenial, or even identical, nature, but diversified in its exterior manifestations by the form and mechanism of the body in which it may be inclosed.

—That the nervous organization of animals can be acted upon by the electric fluid, and the living and sentient principle can be affected by it, we feel, on receiving an electric shock, and know from other phenomena.* In its galvanic form, and in a diffused state, this fluid seems to be the instrument of the living principle, in performing all its muscular actions through some secreting function within us, analogous to that which the torpedo more externally dis-

* The animal frame is affectable by electricity, because, when dead, the galvanic fluid will pass from nerve to nerve, and put the connected muscles into action; but that the principle of life is driven from the animal body by the sudden access of an accumulation of electric matter, we see by deaths from lightning. Other facts show this. On passing the fluid collected in six jars through a guinea pig, from head to tail, he fell as if stunned; some convulsive actions of the limbs followed; yet his respiration was not stopped, and in a few minutes he recovered. But when the quantity in nine jars was discharged through another, he fell on one side, convulsions ensued, and his breathing ceased. He did not recover; though when opened, three minutes after his death, his heart was acting vigorously, and the peristaltic motion was continuing. Med. Gaz. Dec. 1827.

plays. Animal mind is excitable by various stimuli, which act upon the digesting organs of its body;* as the human mind can be both stimulated and stupified by the inebriating liquids.† In some animals, the principle of life continues even when in the stomach of another, resisting its dissolving actions there, and preserving itself in full vigour, though remaining in this bodily grave.‡

It is a curious fact, that the living principle of one animal can, by means of the galvanic agency in its body, act upon that of another.§ It is still more curious, that the animal principle of life can retain its energy, though buried for many centuries by the convulsions of nature amid its rocks and fossils, as if from the diluvian times; and yet can revive into activity on being drawn from its sepulchral cavern into air and light again.‖ The movements that

* Thus game cocks are made to take brandy, balls of food with cayenne and other stimulants, a short time before their appointed contest, to make them more fierce and fearless in it.

† We know that beer intoxicates into stupidity; but when into the mouth of one thus stupified, three spoonfuls of brandy were introduced, and soon after a few more by mistake, the intoxication went off, and the man seemed to have awakened from a long and painful dream. Quart. Journ. Science, No. 12, p. 435.

‡ Dr. Trumpy stated, that in July 1824, a woman had evacuated from her stomach a lunex rufus above three inches long, and two and a half round, which had grown up there from an embryo state, in which it had entered with some water she had drank. Bull. Un. 1829, v. 4, p. 47. . . . . When a heifer, that had been three months ill from some unknown cause, was opened, an adder was found within its larynx, that had but recently died. "A girl, of eighteen, after being much convulsed, discharged a live frog, and, three days after, a dead one. She had been accustomed to drink water from ponds." Preston Chron. 1828.

§ Aldini, about thirty years ago, ascertained that metals were not absolutely necessary for the production of the galvanic fluid; but that it is excited, or collected in the organs of the animal body, and here acts as if the main cause or instrument of muscular motion. He excited muscular contractions by applying the nerves to the muscles of a prepared frog; and gave motion to the limbs of a small cold-blooded animal, by applying to it the galvanic energy of an animal with warm blood.

‖ Professor Eaton, of New-York, stated that the diluvial deposits through which the Erie Canal was made, contained ridges of hard compact gravel. On cutting through one of these near Rome village, sixteen miles west of Utica, the workmen found several hundred of LIVE molluscous animals. They were chiefly of the mya cariosa and mya purpurea. The workmen took the animals, fried, and eat them. He adds, "I was assured that they were taken alive forty-two feet deep in the deposit. Several of the shells are now before me. The deposit is diluvial. These animals must have been there from the time of the deluge; for the earth in which they were is too compact for them to have been produced by a succession of generations. These fresh-water clans of 3,000 years old precisely resemble the same species which now inhabit the fresh waters

have been noticed in the molecules, or atomical particles of bodies, in infusions, or other solutions and decombinations of them, have been referred to the action of a living principle within them. When they are organized seeds, it is not impossible, as these have this vital principle within them, that it may agitate its material envelope;* but the motions of any other particles which are not organized bodies have been deemed, by calmer judgment and more discriminating observation, to be the mere effect of physical causation. The action of light, electricity, the galvanic fluid, heat, or magnetism, may each produce occasional phenomena of this description.†

of that district. Therefore the lives of these animals have been greatly prolonged by their exclusion from air and light for more than 3,000 years." Dr. Silliman's Am. Journal, No. 15, p. 249.

* Mr. Howard examined with a microscope the pollen of the hazel-tree (corylus avellana.) A clear drop of distilled water being put on the glass, the grains imbibed it with the avidity of a sponge, and distended, but without any further motion. On other pollen, a drop of brandy instead of water, was applied. "The grains expand as in the water; but in the meantime are put into rapid motion, each grain darting from side to side with the vivacity of a swarm of gnats in the air. As they approach to complete expansion, the motion dies away; and one after another sinks to the bottom. Presently the liquid begins to be obscured, and, in a few minutes, the grains are mostly dispersed and decomposed." Trans. Linn. Soc. v. 6. Samouelle, Entom. 336.

This phenomena looks like the principle of life suddenly excited into unnatural agitation, and at last separating itself from its material organization. In some human deaths, the body is agitated by convulsive starts and spasms, before the spirit of its life can free itself from its nervous abode. I once saw a distressing instance of this, for the last fifteen minutes. It exactly resembled the action of a soul struggling to extricate itself.

† M. Gaillon had misled himself on this subject, and fancied that these particles could give birth to animalculæ; and these, in their turn, reproduce a vegetable. Mr. Edwards has also suffered himself to be drawn to favour such erroneous theories, and thereby to misinterpret his own experiments. The editor of the Bull. Univ. very justly says, "the exactitude of such opinions cannot be too rigorously proved." . . . . Schulz also imagined, from the movements he saw, that all the saps of plants and the blood of animals were composed of living globules, and that all the bodies of plants and animals were but the aggregations of an infinity of these living molecules; that is, that every man, instead of being, as we all feel ourselves to be, a one individual self—a one undivided personality—is in reality a million of distinct living things: that no man is a single man, but millions of other kinds of beings inclosed in our skin, and making up all together that living creature which we call ourself. Such absurdities ought to be felt to be so, the moment they occur. They are destroyed by the exact experiment and correct observer. Rudolphe and Meyer affirm, that these imagined spontaneous movements are pure optical illusions. Schulz examined his fluids in the full sun; and found that the effects of the light on the particles would produce the motions deemed spontaneous.

There seem to be two distinct orders of existences in the world, unitable at all times with each other, but equally separable from each other; and always maintaining a clear distinction, and a difference which is never lost nor confounded. These grand divisions of what manifestly exist, may be called the material and the immaterial. All that is material is a combination of elementary particles or atoms, always combinable, existing every where in combination, yet always separating from each other, as the decombining agencies of nature cause them to be parted. Every material thing is a compound, and is divisible or separable into the material atoms of which it is composed. By whatever name we may denominate these more elementary constituents, whether we call them corpuscules, particles, atoms, or molecules, all that we see, feel, smell, or taste, is of this character,—an assemblage of smaller material particles into a palpable or visible substance. The subtlest fluids are of this kind, as well as the most solid masses; the gas as well as the rock; though the one are dense, and the other lighter combinations of original elements. Even the finest fluids or material substances that we know, the luminous, caloric, and electrical ones, are still but unions of particles, however minute we may deem them. Such is matter—always an aggregation of separable parts and particles. No material thing is a oneness or a whole, except such a temporary singularity, as the temporary union of its particles into a particular figure, for the time of their mutual cohesion, happens to occasion. This character, matter never loses in

Bull. Un. 1830, p. 42. . . . . The true fact seems to be, as Mr. Brown has stated, that the extremely fine particles of a solid body, *whether organic or inorganic*, when suspended in pure water, or other fluid, show motions which he could not account for. From their irregularity and apparent independence of each other, they resemble, to a remarkable degree, the *less rapid* movements of some of the most simple infusory animals. The smallest were nearly spherical, and in diameter from one twenty-thousandth to one thirty-thousandth of an inch. Other larger particles exhibited, in the same circumstances, analogous motions. He found them also in the particles of sulphur, resin, and wax. Bull. Un. 1828, p. 221. . . . . Thus Mr. Brown destroyed the fond opinion, that the molecules of *organic* bodies were living globules; by showing that *inorganic* bodies and minerals had the same movements; and his further inference was, that these arose from some physical agencies, which is the true deduction. In this light, the experiments are well worth pursuing, as they will tend to elucidate the fine operations of light, heat, electricity, and the aerial agencies on the minute particles of matter; and may lead us to the causes and means of the attraction, cohesion, dissolution and chemical changes of material substances.

any of its forms or modes of subsistence; and this distinguishes the material portion and classes of existence from all that is not so.

To what is not so—to what is not an aggregation or combination of separable particles, we must attach, both in truth of fact, and in the correctness of our perceptions of it, some other appellation; and the simplest distinguishing denomination seems to be that of a negation of identity or similarity,—the not material, the un-material, or the immaterial. Thus we have two appropriated terms that will fully suffice to distinguish the material and the not material portions of existing nature from each other; and by using these, we keep them as distinct from each other in our perceptions and memory, as they are in reality and nature.

The immaterial, or not material portion of existing nature comprises all living principles; all sorts and degrees of sensitivity and mind—the soul of man, and the ever-blessed Deity. Though all very distinct from each other, and the last infinitely so, yet they are all comprehendible under the general term of immaterial existences; because they are all, in the strictest sense of the word, of this description: neither of them are aggregations, or unions of parts or particles. Whatever either may be in its individual qualities and characterizing nature, each has the peculiar property of being a oneness, a whole, a single intirety. None of them can be divided into elementary atoms or molecules. Life cannot be cut asunder, any more than the power of feeling or that of thought. If you take off the limb of a feeling animal, though you disunite that into a separate part, you carry no feeling with it. The severed limb, once severed from that body which contains the sentient principle, has no sensitivity after the amputation. This is the great distinction of all immaterial being. It is indivisible; it is not a composition; it is undissolvable; it is always a one whole; a perfect singularity; an uncompounded thing. The term *being* is more properly its denomination than *thing*; because, being or living existence is also its invariable and inseparable characteristic. Life or being is the universal companion and mark of all that is immaterial. What feels, must live; what thinks, must live; the soul preeminently so. Yet life, as we see in vegetables, is not necessarily united with either feeling or thought. Feeling, is life combined with sensitivity; and this combination may exist without a reasoning faculty, as in the lowest classes of animated

nature. Mind is life combined with feeling and thought; and this may subsist, as in brutes, without the human soul. Our spirit is an additional nature: it is the union of life, feeling, and thought, with its highly born and most distinguished self; and all these orders of immaterial being are realities in nature, distinguishable from each other as they are from the eternal source and Sovereign of them all, the almighty and everlasting Creator, from whom, and from whom alone, all life, feeling, thought, and spirit, have proceeded.

Thus there appears to be in existing nature, so far as we at present know it, and to be there distinctly perceptible by us, FOUR classes or orders of immaterial being, which are not each other, but which are all separate essences or animated things, and which subsist manifestly apart from each other, with very distinguishing properties. The first of these is indeed so superior, that it is almost profane to associate it with the others; but, as it is the fountain of all, it may be reverentially placed at the head of all immaterial being, though with the impression of being at an infinite distance and unapproachable exaltation:—

The supreme eternal Creator of all.
The human soul.
The animal mind.
The vegetable living principle.

Each of the three last is at a great distance from the other, in power and qualities, in descending scale from the human spirit to the plant.

Thus the gracious Deity, as the author and source of all that is immaterial, possesses in himself all spirit, mind, feeling, and life, and has distributed them respectively to his creatures as he has thought fit. The human spirit has also perceiving and thinking mind, sensibility, and the principle of life, but is not its divine maker. Brutes have sensations, perceptions, memory, will, comparing thought, and a deciding judgment. Though varying in degree, they have also feeling and life; but they have not the human soul, and cannot do what that does, nor be what that is. So plants have that living principle which places them in the ranks of immaterial beings; but they have not the animal sensitivity, nor a perceiving or thinking mind, nor a human spirit. They are the lowest order of immaterial being. In them, an immaterial principle is united, in its simplest state, with a material organization and substance. They

are thus a compound of two natures, or classes of existence. They are at the same time material things; and immaterial beings; but they are beings without the sensitivity and degree of mind which animals possess. They are immaterial beings of their own class and kind, strictly limited to that, and clearly defined to the eye and judgment of every one by that limitation; but their material substance is as truly not their principle of life, as their living principle is not their material substance.

As I think on the vast amount of individual beings which our earth contains, my reason is led, among other possible causes and uses of them, to regard them as so many depositaries of the immaterial living principle. As soon as this was created, it had to be placed in a position that suited it. But it never appears to us without a material investment; nor do we know that it can exist consciously and livingly without one, an organized form of some sort or other; and if it is to be preserved in a sentient state, an animal configuration of some species, seems to be, as far as the observable phenomena which attend it justify an inference, its proper and most fitted residence. Magnitude, we have already seen, is indifferent to it. It is as active, as sensorial, as vital, and as intellectual in the ant as in the elephant; and therefore all animal bodies—the minutest as well as the greatest—may be its appointed and most beneficial receptacles.*

But as such a multiplicity of living beings in our world is far more exuberant than any occasions for it on this earth appear to require, the thought is sometimes led to the recollection, that the globe we inhabit is not the only orb of life and substance in creation. We are but one of many worlds; and of these there are a few separated from the innumerable others, which are immediately and distinctly associated with us in one planetary system, and which revolve as we do around one common sun. The peculiar seclusion of these from all the rest, and the appointment of these only to be together, and their manifest combination into one system of being, apart from every other, and divided in space from every other by more myriads of

* Dr. Hartley's concluding observation on the intellectual faculties of animals deserves a quotation. "It ought always to be remembered, that brutes have more reason than they can show, from their want of words, from our inattention, and from our ignorance of the import of those symbols, which they do use in giving intimations to one another, and to us." Hartl. on Man, vol. 1, p. 426.

millions of miles than we can easily calculate—are clear and certain indications, that we have some important relations with each other, which have not yet been ascertained. That we all recede from the solar centre, and yet gravitate to it according to our masses and projectile impulsion, is only one truth—one of our connecting similarities. This fact manifests some general concern with him, and apparently much more than the mere reception of his agencies of heat and light, as these are confessedly very small, comparatively, to the planets beyond the orbit of Mars. But the reason, in weighing all the probabilities of the case, inclines to the conclusion, that we and our fellow planets have more references to each other than are yet known; and, consequently, that our earth is existing for some purposes with which they are interested, as they have also circumstances in their subsistence or destinations which as materially concern us. Here the imagination, having no descried data to lay as the foundation for any real superstructure, can only again indulge in conjectural possibilities. One of these would be, that our earth may be a nursery of the immaterial principle; that it is here brought into its first state of being in animal forms, with a profusion that seems to us unexplainably lavish, in order that it may be elsewhere used in some advanced or ulterior condition, and in other modes of material existence. There is a very large part of our massy and animated globe which has no relation to its human population. The supposition, therefore, seems not irrational, that it may have some unexplored relations with those orbs which have been made expressly to be our fellow planets, and with which astronomy teaches us that our earth has been always associated, peculiarly and exclusively from the immense multitude of the other radiant spheres, that nightly deck the unbounded space above us. But here the mind must pause. It has no authority to inculcate any speculation on this point, as a fact. It is justified in conceiving the connexion to be an indication of relations; but what these relations specifically are, can only be at present dreams of the fancy, and a temporary hypothesis.

But it is in the characterizing phenomena of the vegetable and animal kingdoms, of which a few have been in these letters selected for your consideration, that we find the materials from which we may derive a larger knowledge of our Divine Sovereign and Benefactor, than the

common occupations and habits of life can supply. His mind, as I have before intimated, inevitably reveals itself to us in his creations. The elementary particles of matter are arrangeable into any forms that omnipotent power and wisdom might command. But of all these possible configurations and combinations, he has chosen those vegetable and animal structures which live and move around us. He has deliberately and specifically made them as they are; and therefore they display to us his deliberations and resolutions, the thoughts and purposes of his sacred mind, for our contemplation and instruction. It is this fact, which makes natural history and philosophy so important and so interesting to us. Creation is every where a picture and elucidation of its Maker's conceptions, imaginations, reasonings, feelings, and will. The more we study its departments and individualities in this light, the more we shall know of him; and the more fully and truly we know him, the more we shall admire what we know, and love what we admire. To explore nature without this associated idea, that it is his mind and thoughts which we are beholding in every part, is to forego the sublimest knowledge and sensibilities which are attainable by human nature. The God is in all his works, as much as the man is in his literary compositions. Whatever the mind, in any being, does or displays, discloses that mind to us. Intellect cannot, indeed, make itself known to intellect in any other way than by word or action. Vocal or written phrase, deeds or operations, are necessary to make out thoughts and feelings perceptible or intelligible to each other, and those of our great Sovereign to us. He has chosen the medium of language, whenever he has deemed it proper to have recourse to it; but he holds a constant communication with us by his creations and his providence, by his course of nature, and by his direction of human history and life. It is for us to learn to read them as we ought, and to understand them like beings of an enlightened and enlarging comprehension. They cannot be so studied, without expanding and enriching the mind which thus applies itself to know, feel, and appreciate them. For it is the perfect wisdom of omnipotence that we shall be contemplating; and we all know and daily feel that we can at no time pursue any subject of thought, without imbibing largely the ideas and feelings by which we are interested, and to which

our attention is directed.* Thus the comprehensive study of created nature becomes to us an oracle of enlightened theology, and will prepare the mind for better receiving and appreciating its specific and invaluable revelations.†—

* Cowper has truly said,—

> The just CREATOR condescends to write,
> In beams of INEXTINGUISHABLE LIGHT,
> His names of wisdom, goodness, power and love,
> On all that blooms below, or shines above;
> To catch the wandering notice of mankind,
> And teach the world, if not perversely blind,
> His gracious attributes; and prove the share
> His offspring hold in his paternal care.
>
> Cowper, vol. 1, p. 148.

† As you may be desirous of knowing how the Scriptures represent the condition of the animal kingdom, and the relations which their Creator has chosen to maintain with them, I will briefly notice the principal allusions to them. They were subjected to the dominion of mankind as soon as created, Gen. i. 28; and vegetation was then assigned for their food, ver. 30. Pairs of those genera which were to spread again upon the earth after the deluge, were preserved for that purpose, Gen. vi. 19; and when the human race were renewed, they were permitted to use animals for their food, Gen. ix. 3. But a distinction was afterwards interposed on this subject, and specified portions of each class were forbidden to be eaten, Lev. xi. Lambs, goats, and bullocks were selected for the sacrifices of divine worship. Exod. Levit. *passim*; but their figures were forbidden to be used as sacred images, Deut. iv. 16—18. Their qualities, power, and beauties are declared to have been specifically varied and given to them by God, Job xxxix.—xli. All receive their appointed food in due season from him, Psalm civ. 27, 28; cxlvii. 9; and are called upon to praise him, cxlviii. 10. The ravens were appointed to feed Elijah, 1 Kings xvii. 4. The locusts and destructive insects are represented to be his missioned instruments of punishment and discipline to man, when he thinks proper so to send them, Joel i. 4; xxii. 25. Deut. xxviii. 38. 42. Kindness to animals was inculcated, Deut. xxii. 4; xxv. 4. Lev. xxii. 27, 28. Ex. xxiii. 12; and cruelty reprobated, Deut. xxii. 6. Ex. xxiii. 19. In the final state of the world, the ferocious and the carnivorous will change their destructive appetites and passions, for vegetable food and gentle and playful dispositions, Isaiah xi. 6—9; lxv. 25. Our Saviour represents the birds of the air as fed by our divine parent, without any providing labour on their part, Matt. vi. 26; and declares that the most insignificant of them does not perish unnoticed by their Creator, Matt. x. 29.

LETTER XX.

The formation of man.—The principle and process of his being.—The divine image and likeness.—Nature of human knowledge.—Man's self-formation, free agency, and free will.

THE creation of man is placed by the Mosaic narration, immediately after the completion of the animal kingdom; and this is the period at which our natural reason would, on an impartial review of all the probabilities of the case, be inclined to suppose that his formation occurred, in a world in which he is the preeminent creature, and of which he is the unquestionable sovereign. For, to suppose that vegetables existed for ages before animal life appeared, or that the brute classes occupied our globe for thousands of years before man was made, is not only unwarranted by the fossil phenomena, when justly contemplated and reasoned upon, but is at variance with the most probable plan which a commanding intelligence would form on such a subject; as it also is with the apparent and declared purpose of the Creator in making it the residence of his human race. If the earth had been framed for plants or animals only, they might have enjoyed it for any series of time, however extended. But the coexistence and predominance of mankind upon it, demonstrate that it was not made or meant to be a mere vegetable or animal world. Human beings have always been, so far as all tradition or history reaches, its most distinguished and predominating inhabitants. It has never been known to be without them; and if they have been in the unceasing occupation of it, as far as any investigation of its events and memorials can ascend, it is reasonable to conclude that for them it was principally constructed. When inferior and superior existences are found together, the probability will always be, that the sphere which they occupy, was formed for the grander beings rather than for the less, and not for the inferior only. If the coexistence of both were incompatible, then one must be omitted, that the other may occur; but where all can be and are in harmonious coincidence, the exclusion of either may be safely discredited. It is therefore more likely that man should have been in a habitable world from its commencement, than that either vegetables should have been alone

pervading it for centuries before animal life was called into being to feed upon them, or that organized animals should have for any length of time been left in the possession of it, before that more perfect creature appeared, who was destined to be the lord and masterpiece of all,—who alone can know and govern it,—whose spirit allies him immediately to his Creator,—whose capacity is fitted for unbounded and universal activity and knowledge,—and whose unconfined improvability alone suits that immortal destiny, which hope, desire, belief, reason, and divine authority combine to assure him is awaiting his attainment. That the terrestrial surface should be sufficiently furnished with plants and the intended animals before man was introduced upon it, would best suit his welfare and necessities. But after these had been created, there was no need of delaying his formation; and it is therefore concurrent with the reasoned probabilities of the subject, that the creation of human kind should have immediately succeeded that of their animal fellow-creatures. Correspondently with this deduction, Moses exhibits the Divine Author as resolving, before the sixth day ended, to form that order of beings, to whose dominion he intended to subject the whole terrestrial globe.

The principles on which mankind are declared to have been formed, are, that they should be the image and likeness of their Creator, and should be the lords and rulers of all animated nature.

"And ELOHIM said, let us make man in our image, after our likeness: and let them have dominion over the fish of the sea, and over the fowl of the air, and over the cattle, and over all the earth, and over every creeping thing that creepeth on the earth."*

It was a superb destiny that man should be appointed to be the image and likeness of God; but it is emphatically here revealed to us that this was the object of his creation; and this fact and principle are repeatedly alluded to afterwards, in both the Jewish and Christian Scriptures. It is thereby made a prominent truth, and as such demands our most intellectual meditation. Let us consider by what process this sublime result was intended to be produced.

* Gen. i. 26. "So Elohim created man in his own image. In the image of Elohim, he created him. Male and female, he created them. "And Elohim blessed them, and said unto them, be fruitful and multiply, and replenish the earth, and subdue it; and have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth." 27, 28.

Man consists, like the animal classes, of a material body and of an immaterial principle of intellectual life. But he differs from them in this great and distinguishing peculiarity, that his mental principle is of a diviner nature, and is stated to have originated from the Deity himself. For, after mentioning his material formation from earthly elements, "the dust of the ground," the sacred record expressly adds, that his Creator "breathed into his nostrils the breath of life, and man became a living soul."* He became a living soul, because this divine breath was breathed into his bodily frame. No difference of origin could be more distinctly marked. The regal Solomon has impressively signified his clear perception of it by these discriminating words:—

"Then shall the dust return to the earth as it was; and the spirit shall return unto God who gave it."—Eccl. xii. 7.

I will not enter into a metaphysical description of the nature of the human soul in this letter. We all see and feel its difference from the animal mind, and its great, unapproachable, and ever-increasing superiority. Its progressive, and as yet unlimited, improvability, is quite sufficient to distinguish it, permanently and specifically, from all other classes of life or mind that are known upon our earth. Its origin was the divine breath. It is therefore an emanation from the Divine Spirit, and in this sacred source of its existence, its similitude to its Creator began. Its intellectual and moral powers and qualities may be assumed to have a proportioned resemblance in essential nature, though but in remote miniature, and infinitely inferior. We feel and think in some respect and degree like our great Author, however diminutive the proportion may be—we are addressed by him, throughout all his revelations, as if we did so—he has therefore made our intelligent spirit in such a likeness to his own, that there can be intercourse and communion, and sympathy, affection, and affinity between man and his God. His sacred mind can at all times, from this similarity, make itself intelligible to us and perceptible by us. He can at all times impress our sensibilities, and communicate his influences. We are essentially his image and likeness in our original nature and capacities; and the more steadily and successfully we

* Gen. ii. 7.

advance to all the attainable perfections of our being, the more complete the actual assimilation will become.* It is for us to accelerate this grand consummation of our destiny. At present, the general habit is rather deterioration than progress—a diminution and degradation of the original similitude, instead of its preservation and enlargement.

Thus capacitated by its sublime origin to receive and feel and comprehend the ideas and sentiments of the divine mind, an ample store of these was prepared for the human soul, in the rich, the splendid, and the multifarious creations of the external world which was provided for its habitation. It has been an important object of these letters to suggest to you, or rather to induce you to recollect, what all must perceive and recognise, that in the creations which surround us, we see in actual realization, in visible intelligibility, the mind—the feelings—the thoughts—and the powers of our God. Creation is a peculiar representation to us, and to us alone, of the intellectual nature and capabilities of our Creator. It not only presents his ideas to us in sensible realities, and causes these to come to us in our sensorial impressions, but it is also an intentional selection of such of them as he wished and resolved to become known to us, and to be parts of our understanding. His works within our ken do not show to us all his powers. He has not exhausted himself in our globe. No single world can have such an effect. No number of worlds could completely display him. Omnipotence will always be greater than what it produces. To be almighty, is to have a boundless and endless power of creation;—and whatever such a being chooses to form, is only a portion of what he can create. Each operation is an additional display of his illimitable possibilities. Every one contributes to enlarge the sense and certainty of them, to all who can contemplate them,

* Young's impressive lines have this allusion:—

"How poor, how rich, how abject, how august,
How complicate, how wonderful, is man!
* * * * * *
Connexion exquisite of distant worlds!
* * * * * *
Midway from nothing, to the Deity!
A beam ethereal, sully'd and absorpt!
Though sully'd and dishonour'd, still divine!
Dim miniature of greatness absolute!
An heir of glory! a frail child of dust!
A worm! a god!" * * *

Night 1st.

without ever marking their boundary or approaching to their cessation.

—In the myriads of shining orbs above us, which our science has now attained to descry, and which have been multiplied by improved telescopes, from the thousand to the million numeration, we have so many further representations of His omnipotent mind, and of its realized conceptions and will. Each of these spheres of being contains so many distinct and augmenting displays of his intellectual character and power. It is by his creations only that he can give to his rational creatures an adequate knowledge of his intelligence and potentiality. What he thus makes perceptible to them, is that which is to constitute their knowledge, and to form their ideas; and we cannot have any other. Our science arises from the study of his works, and of their laws and designed phenomena. Nature is his own chosen representation of himself to our sight and observation. He has placed it before us, around us, and above us, in all the forms which the preceding letters have noticed, in order that by contemplating and knowing it, his mind, as there revealed, may become our mind, and his science our science. By this admirable and gracious plan—in this sublime school of divine instruction, which makes the learning we imbibe a delight and a blessing, he begins the process of forming our mind to be thus far the intellectual image of his own—a marvellous result, by a most interesting process; but a result, which no one, who calmly reasons, can dispute or deny.

For, what knowledge have we, but that which is derived from the external world?—and what is that world, but his creation?—and what is creation, but the composition, structure, and arrangement of all things, according to his previous designs, plans, intentions, will, and mandate? In studying creation, in any of its departments, we therefore study his mind: and all that we can learn from it must be his ideas, his purposes, and his performances. No author, in his compositions—no artificer, in his mechanisms, can more truly display their talents and ideas to others, than the unseen Creator manifests his thoughts and intelligence to us in the systems and substances which he has formed, and presents to our continual contemplation. In this sense, nature is an unceasing revelation of them to us.

This grand truth leads us to perceive that the chief object of the multiform richness and diversity of his earthly crea-

tions, which we have been surveying, was to convey to the human mind, and to all its generations from age to age, and as every new race arose to each individual of it, that knowledge and participation of himself which he desired to be a permanent part of the human mind, and to train it into a likeness to his. The various departments of nature which have been briefly recapitulated, the planetary, the terraqueous, the vegetable, and the animal,—constitute the knowledge which he has selected and appointed to be the knowledge of mankind, and to be that portion of his own knowledge which he wishes them to possess. Of this, he settled that our ideas should be formed, and to these, provided materials should be confined, for, beyond them we cannot go. We must furnish our minds from this large and diversified provision. We must give them this knowlege, or none. We cannot give them any other while we reside here. Another world will open a new scene of his creations, and in them afford us new displays of his intellect, and new materials of sensation, perception, thought, and feeling. But in the present, we can only obtain what is before us and about us. Of this, we may take and acquire as much or as little knowledge as we please. The more we imbibe, the more we shall be in this respect his image and his likeness. Most of us are contented with a moderate portion; many, with a general outline; some, with a very slight and superficial survey; others, with almost none. This is left to our personal taste and choice. It is ever inviting us to make it our possession, and it rewards with mental happiness every spirit that will acquire it; no other enjoyment is so unsatiating or so lasting; nor can its abundance be exhausted. The most informed and indefatigable philosopher has yet as much to learn and discover, as he has appropriated. Myriads are now exploring nature in all directions, and find that the more new facts of its beings, laws, substances, and qualities they discern, the more they also perceive remains unfathomed. Nothing in it, that has a material form, can be pronounced to be unknowable. Human sagacity still finds every region of substances, penetrable yet further by its patient industry and continued thought. We are gaining more insight into their principles, laws, and phenomena, every year of our existence. The grand system, and its active agencies, and their diversified results, are becoming more distinctly seen by every fresh generation of human inquiries. The Creator becomes more

fully known as his earthly compositions are better understood; and thus man, his noblest earthly work, is now more completely fulfilling the grandest purpose of his Creator, than at any prior period of his prolonged existence; and is every year advancing, both individually and generally, as society improves, into that resemblance to his Creator, which at his original formation he was ordained to bear.

We need not ask why that particular kind of knowledge which the earthly creations display, was appointed to form and constitute the mind of man, because this question would be equally applicable to every other possible kind of knowledge; and the right answer must always be, that it is what the wisdom of the Creator has decided to be most proper for his human race, most beneficial to them, and most improving. Indeed, all other kinds of knowledge would probably only have a similar result, for they would all be, and could only be, so many conceptions and executed operations of his divine mind—they would be only different portions of his ideas—they could originate only from him. Every sphere of being is but a varied portraiture of himself, so far as its creations extend. Each conveys to its inhabitants that will duly contemplate the works he can perceive, so much of the divine thoughts, feelings and will, as their substances and agencies exemplify. Hence, all kinds of knowledge from nature are valuable to us, and our own world as effective for our improvement, as any other, in this view, is likely to be.

Such an external world having been provided to give to the only intelligent beings that were to inhabit it, who could explore and comprehend it, this knowledge of their Creator, and this participation of his intelligence,—he formed this race of beings upon these principles. He made their bodies of material particles, like those of the preceding animals—he gave them an analogous system of functions and limbs, of nerves and muscles;—but though he assimilated them very much to quadrupeds in their interior structure, he has distinguished them with an external beauty of form, of countenance, of position, and of size, to which no animated creature on earth has any parallel, or to which it makes any near approach. The ape has the greatest similarity in stature and figure, but is deformity itself in comparison with the elegance, the harmony, the proportion, the movement, and the gestures of our superior being. Nothing animal, resembles the varied expression

of the human eye; nothing approaches the charm of the human smile. None have the coloured beauty, the delicacy and the softness of the human skin. None possess man's lofty elevation of head and upward look, and the soul-expressing features of his attractive countenance—interesting and intellectual in both sexes, but peculiarly lovely in all well-nurtured children, and in many a female form. No mind has conceived, and no art produced, any beauty of material figure surpassing that which nature has exhibited in some or other of her human progeny. Has this, indeed, in its most realized perfection, been ever equalled by the finest creations of the painter, the sculptor, or the poet?

The general circumstances which have been observed and stated, of our intellectual nature, and which have occurred to yourself in considering it in your own individuality, must have satisfied your judgment that the human soul is as clearly distinguished from all animal mind, notwithstanding the partial resemblances that exist, as the bee is from the sponge, or the elephant from the oyster. Independent of all metaphysical discrimination, the literature, the history, the arts, the mechanisms, and the manufactures of mankind,—all that ennobles, enriches, and delights a cultivated nation, show at once, with an irresistible certainty, the immense superiority of the human soul. It has discovered and acquired the sciences, composed the works, displayed the feelings, performed the actions, and created the buildings, the ships, the paintings, the statues, the music, and all the other wonders of civilized society. These are sufficient facts to separate the human spirit from the animal mind. That never improves; that, in no age or country, has effected any progression; though it sees, hears, and feels as we do, and thinks and reasons, wills and judges on its perceptions, so far as its appetites are concerned, much as we do on ours. But there is its limit. Beyond that small, though useful circle, it never advances. In our appetites, and in the mental agency which they stimulate and acquire, we have a kinship and a similitude, but no further. When our moral principles begin, when our improvabilities develope,—when we rise beyond our animal wants and desires,—when we study nature,—when we cultivate literature,—when we seek after knowledge,—when the reason and the sympathies ascend to their Creator,—we distinguish our spirit from the animal mind for ever. To none of these things

can that attain. It is incapable either of receiving or of comprehending them; and these ennobling powers and their phenomena express and illustrate the amazing difference which part us from our fellow brutes, more impressively than any verbal definitions or descriptive particularity. Their faculties, instincts, and powers are admirable for their class of being, and enlarge our notions of the benevolence as well as of the all-mightiness of our common Maker; but they bear no comparison with the transcending capacity, qualities, and achievements of their human masters.

The soul of man, indeed, exhibits a greatness, a strength, a penetration, an expansibility, and a creative power, which urge us to inquire if any order of being, except the divine source of all that exists, is superior to what the human spirit now is in its essential nature, and will become in its most perfect state. It is not easy to suppose that any can be superior to that species of being, which the Deity deliberately and purposely made to be the image and likeness of himself, and whose vital spirit was his own breath. What created nature can transcend such a formation and origin?

Seraphic beings may differ in qualities and knowledge. They must do so, if their form and sphere be dissimilar to our own. Our knowledge is derived from our senses and external world, as theirs we may assume to occur to them from their faculties and their locality. All knowledge gives power in its possessor, according to its nature; the power that follows from possessing it, and from acting with it, and upon its suggestions, and by its guidance. This power it produces in the persons that attain it, beyond what others have who are deficient in it. A man who has acquired the knowledge of ship-building, of metallurgy, or of watch-making, has a power which I have not. He can by that do what I am unable to perform—he can make a ship, iron, metal, and instruments, or a watch; as another, who has acquired weaving knowledge, can fabricate cloth or cotton dresses; and other artists a portrait, a bust, or musical concerto, and a thousand other conveniences of domestic and social life.

We have no personal knowledge that there are any beings in existence besides ourselves: but this is no reason for our denying or disbelieving that there are any. We have no personal knowledge of the marine animals that are now

living at the bottom of the ocean, but we may be certain that myriads or millions of animated forms are there. We know nothing of the tribes that are occupying the centre of Africa—the undiscovered islands and the unvisited regions of our earth,—but we can rationally and positively infer that these places contain human beings, as well as many birds, quadrupeds, and insects. We know that the localities for their habitation are subsisting, and we add the deduction of their existence from the analogies of our experience of the rest of our globe, with which we are more acquainted. We make the same kind of conclusion from the radiant orbs we see above us. The planets, which move like ourselves round the sun, and the stationary stars, which seem like suns themselves, are sensible proofs that material worlds exist, on which sentient or intelligent beings may live, as we do here; and it is more reasonable to suppose that they are occupied by such, than that they are mere brute substances, vacant of all life and feeling. No educated mind therefore can doubt, that the universe is replenished with as many spheres of animated beings, as there are radiant or reflecting orbs fitted for their abodes. But it does not at all follow, from the certainty of their existence, that they are, in spirit and intellect, and therefore in the power which results from mental capacity, of a superior order to ourselves.

But the inhabitants of the planetary and starry worlds, and of all ethereal regions, amid or beyond them, must differ from us in knowledge, and in that possess the superiority which any knowledge gives to those who are without it. If their worlds of residence were exactly like our earth, they could have no other materials of knowledge than those which we are enjoying, and would thereby only be on an equality with us; but if the composition, the structure, the laws, qualities, agencies and relations of their places of residence, differ from ours, the knowledge of each order of being must be proportionally dissimilar. Yet dissimilitude is not in itself essential to superiority. Each world would be superior to the other in its own peculiar knowledge, which differed from that of the other, and of which the latter was deficient; but neither might be unequal in the ability to attain it, in the same state and circumstances. Thus, we possess the advantage of knowing the laws, and phenomena, and qualities of our terrestrial habitation, and its living creatures, which angels who do not live among us, but reside

under a different economy of persons and things, have not attained; and they would transcend us in the knowledge and use of all that was peculiar to themselves. They could not form our manufactures, until they acquired our sensations, and learnt, like us, to do so. Nor could we imitate them, without education, perceptions, and exertions, correspondently appropriate.

But knowledge is only the furniture, the materials, and the instruments of the mind—and not the mind or spirit itself. This may be alike in all classes of intelligent being; and their dissimilarities of power and qualities may result from their material frame and appropriated world. As the planets are material structures, and the stars seem also to be extended substance, it would be most congruous with all that we know, to suppose that the beings which inhabit them have also material forms, of some sort or other. It is not easy, from our own experience, to conceive how any created spirit can act on external matter without a material organization. The necessity of this addition to our soul, in order to give it power over outward things, induces us to suppose, that the same medium of effective agency is requisite to all other created natures, that have to live in substantial abodes, and with creatures and things of a similar solidity. Hence it is, perhaps, that our own spirit, to enjoy its destined renovation, and celestial beautification, is appointed to have another corporeal organization, although of a far more spiritual and excelling kind to its present bodily system.

But all science, all phenomena, all knowledge, and all powers, can originate to every orb and order of beings from one source only—the Divine fountain of all. Every world of existence must have been his conception and production; and every form and spirit which are within it. His mind has constructed each; the same mind; the same potentiality; with the same moral and intellectual nature and perfections. But as every being can only act like itself, and be itself in all things—so preeminently the first and greatest of all; and it is therefore to be inferred, that all its creations will display their Maker with a harmonious similarity. He must appear alike in all. His essential character and predominant qualities will mark and pervade every sphere he may form, on the principle, that he cannot but be, at all times and in all things, himself. All the worlds of his immense universe will therefore alike exhibit their Creator to their intellectual populations. He may arrange

the particles of matter into new configurations, and modify his ethereal agencies within them, in millions of millions of diversified forms. He has done so with the material elements of our earth. Both the animal and vegetable kingdoms display, as we have seen, this multifarious variety. But still one principle of formation, one system of creating mind—one maker, one will, one kind and character of intelligence appears in all. Every thing is exuberantly diversified, but nothing inconsistent or contradictory. There is linked and adjusted counteraction; but no incongruity, hostility, or absurdity. We may apply these remarks to every orb of being we survey. The same GOD; the same accordant system of creation; the same forming mind; the same character of thought and will; the same principles of agency and intention; the same moral and intellectual attributes or perfections; the same science and sympathies —may be expected to appear in all, and to cause in all their several inhabitants a similitude of impressions, feelings, and conduct.

From this view, may we not suppose that in nature, virtues, reason, and mental sensibilities, and in the great outlines and constituting principles of knowledge and thought, the angelic classes, and all intelligent beings, and therefore the human race, may have the greatest resemblance to each other?—and that their difference will arise chiefly, from the different use which they make of their essential qualities and attainments; and from the varying and appropriated material knowledge, which the peculiar external world of each may occasion, and enable them respectively to acquire? As far as sacred history has disclosed any circumstances of this sort to us, the parallel has some foundation. There could be a Satan among angels, as well as an Adam among men. Both orders of being are therefore fallible; both furnish instances of transgression. Thus the suggestion, that the human spirit may, in its essential nature, in its improvable capacities, and in its powers and possibilities of progression, be inferior to no order of being which the general Creator has been pleased to form, seems not to be an irrational or an unwarranted conclusion.

One marking principle that accompanies the human soul, seems to be, that it shall progressively furnish itself with knowledge, and form its moral character and qualities. It is placed in a world full of the materials of knowledge, which it is to acquire from its sensations, and by its after

operations on its perceptions; and abounding also with many living beings, and numerous agencies, which force the soul into action in various respects during all its wakeful hours. Amid the impressions and excitations from all these external things, our intellectual being has to form itself into an individual personality, of some sort or other, during the course of its mortal life, as its nervous organization enlarges—as its ideas increase—as its feelings multiply—and as the stimulations and incidents of its daily life successively operate upon it. We strive, by artificial tuition, to give its thoughts and habits, during its younger period, the tendencies we prefer. Instruction is a great assistant: our own conduct a greater. Youth comprehend and imitate what they see, much more than they understand or apply what they hear. But under both circumstances, and in every instance, it is self-formation which forms the matured spirit. The soul is an individual mind, distinct from every other, and always feels and acts as such. It is a separate self, which comes continually into vicinity, and into reciprocating sensations with other selfs, as peculiar, as distinct, and as independent. Each acquires its own sensations; makes its own perceptions and associations; feels alone its own feelings; makes for itself its own reasonings; has and uses its own will, and forms its own judgment and habits. By this separate and distinct self-agency on all its intellectual acquisitions and sensibilities, and amid all the circumstances which occur to it, every soul, as its body grows and as its earthly life continues, forms itself into a personality which is peculiar to itself; which cannot but have many similarities to that in others, from possessing a like frame, and living in the same society, but which always attains and exhibits some qualities, feelings, opinions, and habits particular to itself, and keeping it, while it lives, a specific and individual diversity. Each of us becomes a being generally resembling our habitual associates, but yet distinguished from them all by a special personality of mind, inclination, character, and conduct, with which no other is exactly identified. This difference arises from the principle, that each human spirit is always forming itself through life in its own way, and by its own process, whatever it may be taught and whatever sensations it may receive. It is in no case only or servilely what its sensations make it; nor what any force, persuasion, or education may be directed to form it to be. Each of these, by putting

it under agencies and necessities that impress strongly its attention, and limit its free agency and habits, cause very considerable effect upon it. But amid every impulse, violence, temptation, motive and necessity, to which it can be subjected, or which may be brought to act compulsorily upon it, it will still always be a peculiar self,—a distinct personality,—an individual being,—feeling and thinking and wishing as it may like and choose, though the superior power of other persons or things may fetter its actions. The interior faculty continues to form itself and its mental operations, in its own way and by its own free choice, and cannot but do so, from the essential freedom and independence, on all but its Creator, of its own original and essential nature.

With this principle of self-formation, the soul seems also to possess an original and indestructible property of self-will. This seems to be a natural quality of all intelligence. It cannot but will, as it cannot but perceive, think, and feel; and it cannot but will like itself, because every being can only act like itself, and not like another. It must be that being, before it could do so. The soul must therefore will for itself, as it thinks for itself. This is self-will, as the other action is self-thought. No man thinks in all respects like another,—and no man wills in all things like another. Each thinks for himself, and wills for himself, as he sees and hears for himself; and, as we have observed, also forms himself. Self-will, or the willing according to his own nature—to his individual personality—to his separate and interior self, is therefore the inseparable property of every one. None can divest themselves of their will, more than of their thought. They must will while they exist, as they must so long breathe and live. This self-will always wills according to its own nature, upon its own sensations and inclinations, and as it chooses. Self must not be itself before it could do otherwise. This self-will is that which, under another denomination, we call freewill. It is always free to will, and always wills according to its own choice. In this respect it has no master, and no overruling necessity; and can have none, because it is an essential property of intelligence to will, of which only annihilation can deprive it. The compulsion which we feel, comes not upon our will, but upon our acting on our volitions. We have a natural and unavoidable freedom of will, but we have not as free a power of acting upon our will. All external things

act more or less on our free agency, but not on our freewill The prisoner, blinded, beaten, and chained in a dungeon, can yet will as he pleases, and has repeatedly shown that he does so. Even under the severest tortures, inflicted on purpose to compel him to will as his tormentors require, the human spirit has on numerous occasions proved, that it is not only still exerting its freewill in opposition to the agencies which make it suffer for doing so, but that it can even avow that it will continue to exercise its liberty. Even where it seems to yield to violence, it is rather an extorted verbal submission than an actual surrender of its freedom. It only forms a new self-will in the apparent acquiescence. It wills to comply with the injunctions of the cruel power, in its words and conduct; but I cannot doubt that it also, in its secret movements, wills to hate the persecutor and his requisition, and the conformity to which, in this violence, it assents. Its hostile will remains as it was, and keeps its freedom as strongly as ever; though it wills, for the sake of ending the inflicted pain, to submit to speak and act as the oppressor has enjoined. It seems to me that it cannot but do so. The will cannot destroy its own essential freedom by any act of its volition, as the mind cannot divest itself of its power to think. It may, by new resolutions of its will, alter its expressions of it, and its acting upon it. But that, under the pressure of disagreeable necessities, the human action and the will are continually at variance, though no external sign of the difference is suffered to appear, we may perceive every day in society, and not unfrequently feel in our own personal experience. The will never seems to change but by its own choice, and then it makes the alteration only because it wills to do so. It exerts its freedom in adopting the mutation, because it does not alter until it pleases to change. For these reasons, I infer that this self-will, or freewill, always willing as it chooses, though not often able to act as it wishes, is an essential property of the human soul, of which it cannot divest itself, nor be divested.

LETTER XXI.

On the peculiarities of the human body, which contribute to the superiority of man—his erect head and form—his peculiar legs and feet—his powerful arm and hand—his delicate and sensitive skin.—The female creation.

THE bones, muscles, blood, arteries, veins, nerves, and brain of the human frame—its breathing, digestive, nutritive and circulating systems—its sensorial organs, and its moveable legs—its desire and need of food—and its sensual appetites and passions—are all similar or nearly so to those of most quadrupeds; and are shared by us in common, more or less, with all animated nature. In these we are like other animals, and they are like us—in these resemblances we are so nearly related, that if we were to be judged by a superficial view of our bodily structure alone, the brute and the man would be thought to differ more in figure than in nature, and might seem to be in more fraternal kinship than is usually admitted.

And yet if more closely compared, the human body is found to have some peculiarities, which, even exclusive of its unequalled soul, attach to man a decided and permanent distinction and superiority, which no order of animals can rival, imitate or acquire. Of these it will be sufficient to particularize four differences, which are quite enough to confer on our species the power of subduing, transcending, and governing every other class and kingdom of terrestrial nature.

The first is the os sublime—the erect structure, which both Ovid and Cicero remarked and panegyrized.* All other animals are so framed in their bodily construction as *not* to possess this beauty and this advantage. They are made to be prone, with the exception of the Simia tribe; and they cannot raise themselves on their hind feet without pain, awkwardness, and inefficiency for any continuance. And though the ape and baboon class have more power of supporting an erect posture, yet they cannot do it with the facility, activity, strength, energy and natural ability of man, and do not appear to derive any benefit from it over

* "Pronaque cum spectant animalia cætera terram,
Os homini sublime dedit:—cœlumque tueri
Jussit; et erectos ad sidera tollere vultus." Met. L. 1, v. 84.

Cicero's eloquent allusion to this distinction in man, occurs in his moral "Officia," addressed to his son Marcus.

their fellow brutes. But in the human race, this erect stature is the foundation of their dominion and superiority over all the rest of the animal world.

The second peculiarity is the bony, muscular and ligamentary structure of the human legs and feet; which give to his body in its erect posture, a solidity of support, united with an agility, facility and variety of movement that no other animal possesses, in equal applicability or effective power. By his legs and feet, man is fitted for every kind of motion, except that of flying; and though some quadrupeds excel him in temporary speed, none can vie with him in his universality and diversity of locomotion, nor in his power of continuing it. A man cannot outrun a horse for a limited distance, but in a protracted journey will frequently walk him down.*

The third, and chief distinguishing superiority which I shall notice, is the human arm, with its hand and fingers. This is indeed the sceptre of his power—his instrument of domination—his all-conquering and all-transcending mechanism. It has all the potentiality of an enchanter's rod, and has achieved those wonders of human art, strength and ingenuity, which the magicians of our imagination might toil in vain to surpass. We have not the eagle's talons or the lion's claws at the end of our fingers; but we can arm them with swords, guns, and bayonets, far more terrible. All that we admire and dread, and use in mechanism and manufacture—in art, war, luxury, labour, and comfort—is the produce of the human hand. Anatomy will explain to you the minute and scientific formation and arrangement of our bones, and their articulations in this limb; and of the muscles and ligaments which move them, in such instantaneous obedience to our thought and will. The distribution and diffusion of their appropriated nerves,

* Birds and monkeys, and some other quadrupeds, make considerable use of their toes; but not more than mankind might equal, if they chose to put these flexible and obedient members of their feet into daily use. This appears not only in those maimed persons who have learnt to write and sew with their toes, but also in the general practice of the Hindoo nation at the present day. Mr. Ward, who narrates what he saw among them, says that the toes "in India are second-hand fingers. They are called the feet-fingers in Bengalee. In his own house, a Hindoo makes use of them to fasten the clog to his feet by means of a button, which slips between the two middle toes. The tailor twists his thread with them; the cook holds his knife with his toes, while he cuts fish and vegetables; the joiner and weaver could not do without them. Almost every native has twenty different uses for his toes." Ward's View of Hindoos, v. 1, p. 187.

are also not less remarkable and curious; by which we not only have the readiest exertion of a powerful force and activity, but also of a delicate sensitivity, to which, even the ape's most resembling forehand or paw has no pretension or similarity.

These three advantages give all the bodily efficiency which man's transcending soul requires. Without that informing spirit, little comparative benefit would be attained from them; as that, without these, would be also ineffective; but both united in the combination which occurs in the human race, man is the irresistible sovereign of the globe he inhabits; and in all ages of his existence has attained, asserted, and preserved his predominance—as he was framed and intended and empowered to do by the general Creator.

The fourth great dissimilarity which may be remarked, and which is more immediately connected with our intellect, our sympathies, and our sensibilities, is the beautiful and delicate skin of the human body. Hasty and splenetic men have inveighed against providence, for sending us into the world so naked of all covering—so destitute of natural clothing—so exposed to all injuries and sufferings of temperature and wet—while other animals have feathered, wooly, hairy, horny, shelly, or leathery outsides. Grumbling imbecility! Would any such querulous declaimers exchange their admirable skin, for the hide of a beast, the scales of a crocodile, or the feathers of a turkey? Could any mind that sees, feels, or reasons, desire to have the physiognomy of a horse, an eagle, a lion, or an elephant, instead of the human face divine—instead of its lovely complexion, its eloquent features, its attractive delicacy, and its impressive dignity? But, independent of all beauty, and of all that delights the eye, the taste, and the touch, in the human skin, who would relinquish the mental advantages which we derive from its exquisite nervous sensitivity? We could not have a large portion of our sensations and ideas without it. It is the delicate sensibility of the ends and inside of our fingers, and of our palm, which provides us with an important part of our most useful knowledge. The connexion is unceasing between our mind and its delicate skin. A fine nervous expansion, proceeding from the brain, is purposely spread over the outside of our bodies, immediately under the last cuticle. That our intellect may have the benefit of this universal sensitivity, it is materially associated with our moral feel-

ings and with our best sympathies. No small portion of the tenderness of our nature, and of our compassionate benevolences, are related to it. With the hide of a rhinoceros, or the wool of a sheep, or the shaggy coat of a bear, we should not possess the feelings of a human heart, nor the intellectual sensibility of a cultivated mind. A comparative stupidity, hardness of nature, insensibility, roughness, cruelty, or savage humour, would characterize us in such a transformation, as corresponding qualities accompany other creatures, according as their outside habiliment differs from our beautiful exterior.

But one of the most beautiful, most interesting, and most benevolent ideas of the Divine Mind, in his creation of the terrestrial economy, was the conception and formation of the female sex. No other production has contributed so much to the improvement and to the happiness of human nature. It was the divinest of our great Author's works on our earth; for it was one of the wisest as well as the loveliest of his philanthropic inventions. When he declared, as the reason of this particular creation, "it is not good that the man should be alone,"* he pronounced a truth which every age and clime and nation have verified. The poet's dramatic exclamation,

"We had been brutes without you,"

is not a Parnassian hyperbole—it is the simple and everlasting truth; not perhaps so much to the credit of our sex as our self-love would desire; but it is an applicable comment upon our Creator's recorded observation. If man had been alone upon earth, geography and history unite to assure us, that his populations, if such could then in any other mode have originated, would have been little else than the populations of fierce and savage, violent and battling brutes. In this state, the uncivilized tribes of the earth are found to be, even with the society of women, where these are undervalued, oppressed, degraded, or despised; that is, where they are deprived of that influence which they were created to diffuse and possess—and, by its magical enchantment, to humanize and meliorate. Respect and love of their wives and females may be deemed the great civilizing and advancing principle which has, with some others,—but very probably more efficaciously than any,—contributed to the unceasing progression of the Saxon, Gothic, and German nations, who conquered Europe from the Romans, and spread over it the populations and kingdoms which now adorn it.

* Gen. ii. 18.

with a superiority to their ancient predecessors that has never retrograded.

If mankind had been perpetuated without their milder companions,—from the pebbles thrown by Deucalion and Pyrrha, or from the teeth sown by Cadmus in the earth,—a stony and iron race would have been its perpetual inhabitants. There is something in the active spirit and powers and strength of the manly portion of our common species, which loves difficulties, enterprise, exertion, competition, contests, labours, struggles, argument, battle, and personal display—which hastens to seize its wished objects with precipitation and violence—to fight instantly to obtain them —to strike down all resistance, and to overwhelm all opponents. These qualities and propensities would animate self-love and selfishness into continual strife, conflict, civil discord, and battle, if no softer and kind companions were about such fierce and angry beings, to occupy some portion of their thoughts and attentions—to create and cherish milder and sweeter feelings—and to provide for them the more soothing happiness of a quiet home and a domestic life, where tenderness, sympathy, good humour, smiles, gentleness, benignity, and affection would diffuse pleasures more grateful than those of irritation and contest; and awaken the sensibilities that most favour intellectual and moral cultivation, and which gradually lead us to its attractive and nobler gratifications.

Almost half way between sixty and seventy, I do not wish to express, or to excite, or to recommend those perverted passions and sentiments which disgrace so much of our poetry and literature—which so repeatedly mislead the young—and which hurry so many into habits, imprudences, vices, attachments, or engagements, that make their mature life a series of suffering, disgrace, or adversity. All our amiabilities and virtues—all that is right, noble, and good within us, require, at all times, self-government, deliberation, and judgment. We have not a laudable inclination, nor an innocent propensity, which does not need as much self-regulation as those which are immoral and deteriorating. The remark of Horace is a permanent truth, and universally applicable, that all actions have certain lines and boundaries, short of which, or beyond which, they will be erroneous.

It is the virtuous female and the virtuous attachment which alone produce the benefits I have alluded to.* It is

* Solomon, while he warns us against the dissolute and dishonoured,

a misfortune to us who are now living, that society has fallen into such expensive habits and ill-arranged complexities, that the connubial union often cannot be formed without involving pecuniary evils, which convert its happiness into disappointment, privation, and anxiety. This ought, if possible, to be rectified; but as it has arisen from individual errors, I fear it cannot be rectified but by individual wisdom. Prudence must pause till it can adjust the opposing incompatibilities. These, however, are considerations attached to our present condition of civilized society, and do not belong to its primeval state. The general argument remains the same, whatever be the injudicious customs of any modern communities, or the results of our personal misconduct—and this is, that the female sex were created with such a frame and such qualities as to be a blessing to ours, and to all their human race—that they have in all ages operated to make the male species better, wiser, and happier in proportion as their gentler nature and dispositions have been what they ought and were made to be, and have had any influence—and that they may fairly claim to be the authors of more than half the virtues, amiabilities, improvements, and comforts, which are now diffused through human society. Alone, their defects would have nullified many of their excellences. It is the combination of the qualities and excellences of the two sexes, on which the improvements of human nature depend; and this appears to have been the wise and kind principle of their Creator, in his system of the formation of his human race.*

who disgrace their sex, does full justice, and with an animated pen, to its nobler portion, who now, in England at least, form its general character. It begins with his declaration of the virtuous woman, that "her price is far above rubies;" and ends with that interesting intimation, "Her children arise up, and call her blessed: Her husband also; he praiseth her." Prov. xxxi. 10—28.

* Hesiod has left us his estimate of the women of his days, in his picture of the formation of the first—his Pandora, or Grecian Eve; half admiration, half satire:

"By the advice of Jupiter, Vulcan made her out of the earth, like a modest virgin. Minerva zoned and adorned her. The divine graces and dignified persuasion placed their jewels around her body. The seasons, in their beautiful tresses, crowned her with vernal flowers, and Pallas adjusted the harmony of her form and features; when, by the counsel of Jove, his messenger Mercury framed within her *falsehoods*, winning phrases and *deceitful* manners, and gave her the power of voice." Hes. Op. v. 70—1.

The Grecian ladies may have deserved the Ψευδεα and επιλοιπον ηθος; but might fairly allege that they had these from their male countrymen, and not from nature; as the mendacity of the Greek male population was the frequent theme of their Roman contemporaries.

LETTER XXII.

The first state and residence of the human beings created—the beginning of language—the fall of man—corruption and vices of the general population—its universal destruction by a deluge.

THE Deity having formed his human being, and stationed him in a pleasant region of the earth, watered by a river, and where he caused the riches of the vegetable kingdom to grow; in this selected locality—the garden of Eden—a paradise of natural beauty and delight—he introduced to Adam the Eve that was to share his kindest affections, and to form his chief earthly happiness. He began the intellectual education of his rational creature, by causing the various classes of the animal kingdom to approach him, that he might observe their qualities, and from these attach to them the verbal sounds or names by which he would afterwards know and distinguish them. This incident implies that Adam was also taught to put his provided organs of speech into their appropriate action, and to modulate his breath into varied articulations of audible voice. Language thus began with the names of living things. The first words were the notations of existing substances—the true foundation of all human speech. From the sensations and names of actual things, the mind proceeds to their qualities and motions; and then ascends to the higher operations of marking its own feelings and emotions; of communicating its ideas and affections to fellow-beings, and of knowing and understanding them. Thus language arises and expands. It began in paradise, from natural realities, and has been enlarging ever since, as the knowledge, thoughts, sensibilities and reasoning of the human race have multiplied in their various societies and in each individual soul.

We now approach the great mystery of our creation, the fall and sin of man: his loss of primeval happiness, with the departure of primeval rectitude; the commencement of moral evil, and of personal suffering from that and from natural agencies; the introduction of pain; the deterioration of human nature; the defection of man from his Creator; the assertion of human independence; the rejection of all other control; the reign of self-will; the refusal of self-government; the preference of self-indulgence to self-

restraint; the dislike of a moral superior, and of a commanding legislator; the alienation of the human heart from its God, and the persevering tendency of the human mind to obey no invisible Lord; the devotion of the spirit to its present enjoyments, and a disregard of future consequences; a carelessness of inevitable death, and an indifference or dislike to a future state of existence beyond it: Whatever opinion we may form as to the original causes of these errors and mischiefs, the fact of their occurrence, prevalence, and continuance, is indisputable. They appear prominently in every page of human history—in the characters and conduct of all ages and nations—in the daily habits and transactions of all existing society—in our own individual hearts and lives. Such a being, man has been ever since his primeval and paradisiacal day—such he perseveres to be: and yet a very small use of our reasoning faculties cannot fail to satisfy every candid mind, which covets only the right of judgment and the unprejudiced truth, that in such perversity as this he could not have been created. To be such a mutilation of that divine likeness which he was destined to wear and appointed to acquire, cannot have been pleasing to the Great Perfection, whom he was to resemble. It is a counteraction to his purposes, and a frustration to his design—it is the temporary defeat of his gracious purposes in our existence—it is the present triumph of what is most hostile to him—it is indeed the result, which, as our Milton has sung, has

"Brought death into the world, and all our wo."

But into the primitive history of this catastrophe, and into the philosophical considerations that will arise as we meditate upon it, I will not at present enter, for two dissuading reasons: the first—that to do justice to the momentous subject, would require a longer space than the limits which I have assigned to the present letters will allow: and the second, and not the least influential motive also, is, that it cannot be contemplated, so fitly and so extensively as it ought to be, to be rightly comprehended and appreciated, without some reference to the course of things and history of mankind after the deluge.

From this period our present course and condition of natural and moral evils more immediately flow. They are what they are now, under the system of nature and altered constitution and position of mankind, since the

revival and reproduction of our species, subsequent to that desolating catastrophe. Our present vices and follies are more connected with our present state of being, than with the primeval formation or paradisiacal location of our first erring ancestor. I will therefore defer that representation, and those reflections which may assist your maturing mind to think and feel justly and fairly about events and changes that we must all lament, and desire earnestly to remedy—until I find sufficient opportunity and ability to lay them before you, as I should wish to present them to you. It will, on this plan, be only necessary to allude now to the calamitous results.

With these you are familiar. The dislocation, from a condition of unmingled happiness, into the common world, where labour, trouble, and sorrow were appointed to accompany moral delinquency, as they do at this day—the destruction of one brother by the envy, resentment, or morose caprice of another—the separation of the increasing population into two grand divisions of society—the better and the bad—till the progress of time brought them into intercourse with each other, when all became contaminated with the spirit and habit of common violence and immorality—these were the unhappy effects of the primitive departure from reason and obedience; and the depravation became so universal and so irremediable under that constitution of nature and of man, which had been created for a grand scale of his existence and felicity, that the Sovereign Lord and superintending benefactor thought it fittest for the welfare of all succeeding races, that the corrupt population which were then disgracing and spoiling human nature, should be suddenly extinguished. A deluge was the appointed visitation to accomplish this change: and no general mode of destruction could be less painful or more instantaneously effective, or present more durable monuments of its cause and operations. From this catastrophe, one family was excepted, and preserved in an artificial fabric built by them for that purpose, as commanded, on a premonition of the intended calamity.

In this ark of safety, such of the animal world as were intended to replace the genera that would perish, also found a shelter. And when these provisions for repeopling the earth with its animated races, in the new state and course of things that were ordained to succeed this calamity, were completed, the tremendous revolution occurred. "The

fountains of the great deep were broken up, and the flood-gates of the heavens were opened."* From above and below, the waters gathered upon the surface and multiplied upon it, and rolled terrifically over it, till they covered the high hills, and destroyed the offending generation and every substance that was then existing with the principle of life upon the habitable ground. We can but faintly conceive the appalling scene. Mankind were surprised, in the midst of their usual festivities and employments, by the sudden alarm of portentous danger rapidly rushing on them from the blackening and howling sky. The sun was seen no more—midnight darkness usurped the day—lightnings dreadfully illuminated—thunder rolled with increasing fury—all that was natural, ceased; and in its stead, whirlwind and desolation—earth rending—cities falling—the roar of tumultuous waters—shrieks and groans of human despair—overwhelming ruin—universal silence!—and the awful quiet of executed and subsiding retribution!

THE END.

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PROSPECTUS.

THE publishers of the "BOY'S AND GIRL'S LIBRARY" propose, under this title, to issue a series of cheap but attractive volumes, designed especially for the young. The undertaking originates not in the impression that there does not already exist in the treasures of the reading world a large provision for this class of the community. They are fully aware of the deep interest excited at the present day on the subject of the mental and moral training of the young, and of the amount of talent and labour bestowed upon the production of works aiming both at the solid culture and the innocent entertainment of the inquisitive minds of children. They would not therefore have their projected enterprise construed into an implication of the slightest disparagement of the merits of their predecessors in the same department. Indeed it is to the fact of the *growing abundance* rather than to the *scarcity* of useful productions of this description that the design of the present work is to be traced; as they are desirous of creating a channel through which the products of the many able pens enlisted in the

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"'The Son of a Genius' will afford a profitable study to parents, as well as an exquisite treat to youths. It is an admirable tale: fascinating in its delineations, admirable in its moral, just as a picture of the mind, a faithful and true portraiture of the results of genius vaccilating, unapplied, and turning to ruin, and the same genius supported by sound moral principle, strengthened by judicious exercise and continuous effort, useful and triumphant. It is a striking illustration of the importance of method, perseverance, and industry to produce the perfect fruits of genius; and the utter uselessness of delicate taste, vivid conception, rapid performance, aided by generous affections and engaging manner, to the attainment of excellence, without that *steady application*, which nothing but just moral principle can ensure. The story is not, however, a refined, metaphysical disquisition on genius; but a simple, engaging tale, which lets in upon the reader a sort of experience worth a hundred essays."—*Connecticut Journal.*

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The wonders of God's providence, as they are manifested in the figures, habits, and performances of the various creatures which fill the earth, the air, and the waters,—the endless varieties of form, the accuracy and ingenuity of their contrivances, whether for security or sustenance, and the admirable adaptation of their instruments to the works their instinct prompts them to construct, supply an exhaustless theme for observation and astonishment, and call forth in the mind the most exalted ideas of the Supreme wisdom and beneficence. In the captivating volume which forms the sixth number of the Boy's and Girl's Library, a portion of this department of science is treated of with consummate ability, and the work has deservedly received the highest encomiums, not only for the extent, utility, and interesting nature of the information it conveys, but also for the skill with which the ideas and language are adapted to the tastes as well as the capacities of youthful readers. But these are not its only or its greatest merits: its highest claims to praise are the tone of sincere and earnest piety which pervades the conversations, and the excellence of the precepts drawn from the wonders they disclose.

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